AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Headquarters of the Society: Saint Joseph, Michigan

ARNOLD P. YERKES, *President* RAYMOND OLNEY, *Secretary-Treasurer*

VOLUME 18 AUGUST 1937 NUMBER 8

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Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the headquarters of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .
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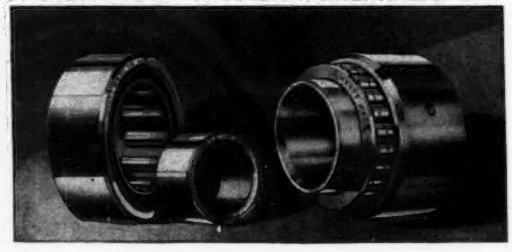

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AGRICULTURAL ENGINEERING

VOL 18, NO 8 · EDITORIALS AUGUST 1937

Engineering in Biology

A new and broader concept of the field of agricultural engineering was given to the American Society of Agricultural Engineers in the annual meeting address by C. O. Reed, appearing in this issue. While disclaiming any credit for originating the idea, Mr. Reed has strengthened it materially by keen analysis and clear statement.

The traditional view that engineering could be carried to the industry of agriculture as a specialized application field, as it has been carried to the industry of mining, has not satisfied Mr. Reed. To him the basic unit of life, the living cell, is a physico-chemical structure made of materials and involving energy transformation and transfer. "The biological kingdom is the earth's greatest realm of energy transformation and transfer."

Agriculture is an industry of transforming and transferring energy and materials with biological structures and machines. In the non-biological field, energy and materials have yielded to a methodology and a concept of efficiency called engineering, with resulting profit, comfort, and convenience to mankind. Mr. Reed believes that materials, processes, and problems of fundamentally the same type are inherent in biology, and that they will yield to the same general type of methodology and efficiency concept, with similar benefit to mankind. By this philosophy, agricultural engineering is the engineering of agricultural biology. The problems and opportunities are waiting recognition and action. Those who follow the lead of this concept will be, in fact, agricultural engineers, regardless of what they may call themselves. It can be the field of the present line of agricultural engineers, if they will preempt it by acknowledgment and mastery.

Mr. Reed finds support for this view of agricultural engineering in the understanding, acceptance, and support readily given to it by engineering and agricultural leaders and the public. It does not step on the toes of older branches of engineering. It suggests a way of solving many problems that agricultural leaders want solved. It works from within and as a part of agriculture. It offers the public the hope inherent in the opening of a vast field of new knowledge.

Every present and possible farm crop, every form of animal life that is or might be used in agricultural production, offers opportunity for engineering analysis as to source materials, composition, structure, energy changes, end-product characteristics, energy and material efficiencies, environmental influences, possibilities of control, and practical production economics. Mr. Reed's concept of agricultural engineering challenges all service branches of the field—education, extension, and commercial development —and all of its technical divisions. We believe that any and every agricultural engineer may be able to see new light and new opportunity in his particular job and abilities by looking at them in their relation to the engineering of agricultural biology.

Extension Objectives

"I BELIEVE someone could render a real service if he would write a short common sense extension bulletin on kerosene lamps . . . ," says Dr. C. W. Warburton in his paper elsewhere in this issue. More generally speaking, the question he brings up is whether to help comparatively few people make great advances, or to help the great mass of people with the short steps they might make. His implication is that the tendency is to help most the few who need it least.

From the standpoint of extension efficiency and the production of tangible results, the most fruitful group with which to work is the scattered minority of progressive farmers who are not afraid of "book learning;" who are both willing and able to understand, adopt, and correctly apply new ideas and methods, and who, for the same reasons, are already far ahead of most of their neighbors. Commercial extension men find their greatest opportunity with this group. The public service extension men have, in support of their working with it, more than a selfish desire to make a good showing, or the pleasure of working in responsive fields. From at least one viewpoint, they may thereby be rendering the greatest public service. Available time, facilities, and funds being factors limiting the number of people who can be reached and benefitted, why not work with the most responsive, and give them the help they need to progress still further? Possibly many of their neighbors will learn best by following their lead.

From a sociological viewpoint it would seem desirable to broadcast the fruits of research to the largest possible number of people. It is the masses who pay the bulk of taxes, and who determine general levels of living and progress. America has grown and progressed on the strength and freedom of its masses. If they can be helped to greater group progress, higher levels of living, and increased earning capacity, a real step in the progress of civilization may be achieved. The extension man's question is not "why" but "how."

If the agricultural masses are to profit by the efforts of extension men, they must have the will to progress, faith in the source of information, willingness to try ideas new to them, and the mental grasp to learn how to apply new methods and to use new equipment. There are undoubtedly many who have these qualifications. Some are young men starting with small capital. Some have suffered capital losses through adversity. Some simply need an occasional understanding boost to keep them in the current of progress. Many will need persistent and painstaking encouragement to get out of unprofitable ruts of habit.

A leavening of work with this group will undoubtedly be good for the soul of the extension man. But as a basis for judgment as to where the main effort should be placed to do the most good, the sociologically desirable end of mass advancement and the practical possibility of its achievement must be measured against the financially desirable end of large visible progress by a responsive minority. The relative ultimate values are obscured by many considerations.

Fuel Sense

PAPERS on tractor fuels published in this issue are representative of a developing sense of responsibility for adequate engineering in supplying farmers with power from an exhaustible natural resource.

Mechanical power has been made available to farmers. In further development of the prime movers there is a problem of providing optimum operating characteristics, including convenience, at minimum overall cost. Elements of cost influenced by the fuel used are investment, operating cost, and maintenance.

As Mr. Duffee points out, "There is definitely a place for each type of equipment and each type of fuel." That is from the standpoint of the kind and amount of use to which farmers put their tractors, and of practical considerations of fuel supply.

Petroleum refining and cracking have progressed to a point which suggests the possibility of nearly 100 per cent use of crudes by fractioning to supply active market demands, with a minimum of low-priced, drug-on-the-market, by-product fractions. This should result in less poor fuel being offered to farmers on a price basis.

The possibility is also suggested of closer specification of the fuels less volatile than gasoline, to provide more uniformly desirable operating characteristics. And with fuels of established characteristics, motor design could progress to provide optimum performance with specific fuels.

Farm demand and market for improved tractors and fuels exists. Technical feasibility is indicated. Closer specification and definition of the performance characteristics of fuels and motors should help protect the legitimate industries and farmers from misrepresentations. A field for co-operation is open. The co-operative attitude shown, applied in the directions indicated, seems to be just good fuel sense.

Technology and National Policy

THE MOST constructive contribution to national economic and social policy that has come to our recent attention is that compilation of facts and enlightened viewpoints just published by the National Resources Committee, entitled "Technological Trends and National Policy."

Its emphasis on the social implications of scientific and technological progress strikes close to the heart of current problems. It recognizes that technical progress often disturbs the status quo, to the apparent detriment of various individuals and classes. It looks for improvement of this situation, to facilitating adaptation to change, rather than to reversing the wheels of progress.

Agricultural engineering, as one phase of technological progress, is duly recognized. Mr. S. H. McCrory, chief of the U. S. Bureau of Agricultural Engineering, was chairman of the committee which prepared the section on technology in agriculture. His staff in the Bureau contributed material on mechanization and engineering, including consideration of farm labor efficiency, rural electrification, refrigeration, farm buildings, and reclamation of wet and of arid lands. Other fields of agricultural technology, in which agricultural engineering is implied to greater or less degree, are emphasized. They include control of insect pests, weather and forecasts, soil use and conservation, chemical fertilizers, aids to marketing, industrial utilization of farm products, dairy production, and cotton pickers.

The report and publicity given to it have enabled political leaders and the public to become well informed on present and probable future problems of technological progress. Constructive attitudes toward the solution of such problems have been given a hearing. The recommendation of a permanent committee or planning board to help keep the country abreast of technological progress looks toward living with such progress and utilizing it, rather than fighting it as it has been fought in the past. If it can be realized, a new era will be started, in which agricultural engineering may be expected to take its proper place.

Social Understanding for Engineers

ENGINEERS were again enjoined, at the recent meeting of the Society for the Promotion of Engineering Education, to carry their understanding of machines beyond the technology of construction and operation, into the social implications of machine use. While this is no new idea, new eloquence on the subject provides food for thought.

Dr. Thomas N. Whitehead, of Harvard University, in presenting the viewpoint said, in part, "If the engineer is to be of help to his society, rather than a disruptive influence, he must be in essence a social leader who has at his command certain scientific skills."

"At the present time one thing is noticeable. The major unrest in this country is not occurring among the lowest paid workers, but, on the contrary, in those industries where pay and physical condition of work are among the best that the world has ever seen. ******* I suggest to you that industrial unrest is greatest in large cities and communities of recent growth, where thousands of men and women have been drawn from all parts of the country in pursuit of paid work made possible by the inventions of the engineer.

"Until educational establishments regard sociological research as being of equal importance with research of a more strictly engineering nature, it is inevitable that the student will conclude that all he needs is a knowledge of applied science and mechanisms, and that their application to society can be safely left to the man who pays the bills."

Agricultural engineers, periodically faced with the need of explaining and justifying their existence, have probably given as much thought to the social implications of their work as any other branch of engineering. But technology progresses. Social attitudes and organization change. Each change and step of progress in either influences the other. If agricultural engineers are to apply their technology for social purposes, on their own understanding of such purposes, the interrelationships demand continuous study. Agricultural engineers will need to be trained for the job. The field of opportunity is undoubtedly great for those individuals who have the capacity to achieve social understanding along with technical proficiency.

Agricultural Engineering and Its Public

By C. O. Reed

THE American Society of Agricultural Engineers and I almost grew up together. Although I missed the Society's organization meeting at the University of Wisconsin in December 1907, I have attended most of the annual meetings since, and well do I remember the 1908 meeting held on this campus and attended mostly by the handful of invincible faithfuls who were charter members of the Society. I may look older than the living charter members, yet I feel much younger than they seem to me for the simple reason that I have never lost a particle of that reverence with which I held them when they were doing things in a big way and I was simply a student prior to June 1911.

Someone should write an unabridged history of agricultural engineering development in this country, which of course was enduring long, long before the origin of this Society. If some of my predecessors do not make this contribution, I may attempt it because from my researches into the past and from my experiences during the last thirty years, I am convinced that our ability to interpret keenly or to understand tolerantly the present, and our ability to prepare wisely for the future is quite dependent upon some knowledge of various relationships in the past.

On this occasion when I am to respond formally to the highest award of the agricultural engineering branch of the engineering profession, I shall not burden you with history. Yet I will draw a bit from it in an endeavor to make that contribution which seems most apropos at this particular period of our professional existence.

PUBLIC'S CONCEPT NATURALLY IS NARROW

If you ask a number of persons, picked at random, what first comes to their minds when engineering is mentioned, almost invariably the answer is "bridges, skyscrapers, roads, dams, machines." I have been impressed by the frequency with which machines are placed late in the lists. This narrow concept of engineering in the public mind, and the order in which engineering creations usually are visualized by the layman, is perfectly natural; and an understanding of the causes is of considerable importance to us right now when we are considering length and content of college curricula, when we are differentiating between service and professional courses, and when we are asking questions about the recognition given agricultural engineering.

In the first place, appreciations spring from understanding which generates with useful knowledge by the route of experience. Lack of understanding of any specialized field handicaps the ability of an outsider to appreciate the hidden problems of the field, and to appreciate the usual processes by which those problems are solved or by which attainment in the specialty is achieved. The layman sees easily only the end product.

For instance, to the general public the new, majestic Golden Gate Bridge is a magnificent engineering creation as a finished entity spanning the banks of a harbor. But to engineers the bridge is much more than that. Because of our understanding, knowledge, and experience in engineering, we fairly thrill with appreciation of the professional vision, analyses, and other abilities and skills that reflect in the solutions of tough problems and through the intricate processes of accomplishment. To us the bridge is a monument to a magnificent series of coordinated ways and means, the emolument of living, dynamic processes which are working constantly as a spirit in all sorts of engineering activity. To us the bridge typifies living achievement as well as being an end-product entity reposing lazily across an inlet.

In the second place—referring again to the public's consideration of engineering, and the order in which engineering creations are thought of—man's memory is influenced directly by the degree to which he is impressed, which in turn is influenced by novelty or uniqueness in contrast to what has assumed mediocrity through custom. We are impressed by the highest skyscraper and by the largest dam not only by their uniqueness, but also because they are entities easy to visualize. But we have almost forgotten the marvels of such intricate mechanisms as four-color printing presses and multiple-operation milling machines, for the simple reason that we have gotten used to them. And we forget even more easily the marvels of less tangible things like radio communication.

The automobile is so common it is just taken for granted. I dare say that as great as the mechanical engineering accomplishments have been on the car itself, the industrial engineering achievements in its manufacture have been just as great, because it is only through the latter that the price of cars has been brought within reach of enough users to bring about so quickly the phenomenal changes which must be accredited to the automobile industry. The public lives these changes every day; yet it is just the car itself as a mechanical entity which the public conceives of when automobile is mentioned.

So we must realize that the public sees mostly only units or entities which are the easily discernible end products; it tends to identify a profession by this simple type of visualization; and, for a time at least, the public appreciates unique things particularly. But unfortunately human behavior is such that the public either has not the time, or it has not the incentive, or it has not the means or opportunity to acquire that understanding from useful knowledge or experience which is necessary to bring adequate appreciation of the internal functions and processes of a specialized field of activity.

SAME FACTORS AFFECT AGRICULTURAL ENGINEERING

The analogy of the above cases to our own field is obvious. Our own immediate public is composed directly of farmers and their families, county agricultural agents, vocational agriculture teachers, students, officers and workers of agricultural associations, botanists, zoologists, bacteriologists, entomologists, agronomists, horticulturists, animal husbandmen, dairy technologists, economists, sociologists, faculties, deans, station directors, extension directors, engineering societies, presidents of state colleges, state directors of agriculture and forestry, advisers of agricultural move-

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An address as the 1937 recipient of the Cyrus Hall McCormick Gold Medal awarded by the American Society of Agricultural Engineers, and delivered before the annual meeting of the Society at the University of Illinois, Urbana, June 23, 1937.

Author: Professor of agricultural engineering, Ohio State University. Mem. ASAE.

ments, and federal administrators, including the Secretary of Agriculture and the President of the United States.

Very few of these persons have had engineering training and only few more have had sufficiently intimate contacts within the realm of engineering to understand fundamentally all of the functions of true engineering in their broader sense. When agricultural engineering is mentioned, it is perfectly natural, therefore, for our public first and mostly to visualize farm buildings, tractors, implements, dams, terraces, ditches, and power lines as entities set into agriculture, and as being agricultural engineering's chief contributions and responsibilities to agriculture.

This limited viewpoint on the part of our public keeps us in the proverbial peck of trouble. The fact that agriculture existed long before agricultural engineering was spoken of does not allay difficulties, and troubled waters of misunderstanding are churned further by a narrow assumption that we carry to agriculture something from the outside. The difficulties may be looked upon as handicaps, struggles, misunderstandings, conflicts, dilemmas, or just plain peculiarities. You know as many illustrations as I do, but permit me to cite a case or two to show the type of difficulty I have in mind.

Not infrequently in local, state, and federal activities, the agricultural engineer is excluded from high councils of other agricultural scientists until the latter decide that they want a mechanism, a building, or a dam. Then the engineer is called in to build it. Such an attitude reflects a narrow viewpoint of others that mostly we must be service technicians. Of course some chores are rightfully ours. But we resent doing just chores, realizing as we do that every branch of agricultural science involves phases of fundamental engineering in its technical sense, and that the interrelations of these branches involve types of engineering analyses, coordination and management.

Architects can draw plans for buildings, and local carpenters can and do build farm buildings; mechanical engineers design tractors, execute splendid fuel researches, and build implements; civil engineers can construct dams and plan ditches; and electrical engineers can lay out and erect power lines. Hence, if our public is left with the impression that these activities constitute agricultural engineering, or that we simply carry the so-called older lines of engineering *to* agriculture, we leave deans and faculties of engineering in a quandary as to our status, and with the erroneous fear that we propose to compete directly with other forms of engineering.

Another difficulty exists because farming is so old, and the term "agricultural engineering" is so new comparatively, that agriculture is slow to let its traditions yield to the seeming novelty that engineering stands for something besides units themselves. For instance, some rural economists still account the horse in animal husbandry when he should be accounted in our own area of power coordinations. If a farm's buildings are appraised higher than its land, some economists have advised neglect or destruction of the buildings in order to reduce their burden. But engineering—which always must be sound economics and good sociology—says that buildings are necessary for land utilization; therefore, rather than threaten security and also foster further loss in physical plant, the problem is to discover ways of farming and of management whereby necessary investments may be maintained. Otherwise the farm loses its security or chance for continuance.

The gross annual income on Ohio farms in 1935 was approximately 275 millions of dollars, derived from land appraised then at 1 billion, 30 million. Between this income and the land from which it came stands another investment in things which our public visualizes as the chief components of engineering interest, namely, buildings, tractors, machinery, drainage and irrigation systems, electrification equipment. This engineering investment is valued at 1 billion, 90 million, which is 60 million more than the stated, appraised value of the land itself.

It is the engineering investment that makes production and healthful living on land possible; and we know that as the engineering investment goes, so goes the farm. No small part of our job is to discover ways and means of adequately maintaining that investment to secure the business. There is evidence that perhaps 10 per cent—certainly not more than 20 per cent—of what should be spent is being spent for that maintenance, yet that maintenance now is as important as nailing down the land itself. How to secure the remaining 80 per cent is an unsolved problem as serious as it is vital. No one yet has whipped that problem for our state or for the nation; and if we do not lick it, it will "take us." The ugly problems in this 80 per cent area compose part of the realm of research and extension in agricultural engineering. The engineer must—because, if he functions as he should, he is the one most likely to—find ways whereby farmers can organize farming processes and programs which will maintain efficient production and a decent standard of living, not alone for normal or good times, but even more for those adverse periods when farmers are threatened with extinction by extremes in weather, in price fluctuations, and in land speculation. When we consider that adverse periods usually cause migration from city to country, and that about every third generation the population of cities is almost entirely regenerated by an influx of blood from rural districts, we appreciate some of our involved responsibilities in the way that our own public and the general public should conceive of them.

In the illustration just given I have used Ohio data because similar data for the entire nation are not at hand, and some are hard to secure. If we had them for all states, I am sure they would compose an impressive and intelligent picture for national consumption. Having inserted the illustration at this point may seem digression, but I have done so to substantiate your belief that our field

AGRICULTURAL ENGINEERING ECONOMICS, IN THE FORM OF FARM OPERATING EFFICIENCY STUDIES, CAN MAKE A MAJOR CONTRIBUTION TO AGRICULTURE

is much broader than the simple units or entities which our public sees.

If we want to peek at some opportunities for agricultural engineering economics we should study carefully the farm operating efficiency project fostered by the U.S. Bureau of Agricultural Engineering. If this project is properly executed toward the broad objectives which can be set for it, it can develop into one of the biggest propositions in the field of agricultural engineering, and one of the most significant contributions in agriculture during the past 70 years. I heartily recommend your study of its possibilities, and your unstinted participation in it on the basis of those possibilities.

A member of this Society, who is a registered agricultural engineer in one of our states and an agronomist of repute, originated a mathematical scheme for determining what is called the "soil productivity balance." In this method, all factors are assigned numerical values which, when weighted for acreage or quantity, reduces soil productivity to a common denominator expressed by a single mathematical value. I would not be at all surprised to see this scheme adopted later as the basis for AAA payments nationally. If such technique can be devised by an agricultural engineer for interpretations within the complex field of soil-crop relationships, agricultural engineers can devise what might be known as a "farm efficiency and maintenance balance." Obviously the scheme would involve the intricate relationships of a number of constants and of variables playing within classes of limits which can be identified and evaluated by engineering analyses and methods. This would be a marked contribution in agriculture.

One of our esteemed members once stated that some factors in agriculture seem to use economics to discover what cannot be done, but that the engineer uses economics to discover what should be done, then ways of doing it.

OUR SIGNBOARDS MISLEAD

Some of the signboards we use do not alleviate in the least the difficulty we have with public conception of us. We have a Power and Machinery Division of the Society, also a Farm Structures Division. By those terms we emphasize units, entities, end products, instead of processes. In college catalogues we find most agricultural engineering courses still titled by terms tending to influence the public to believe that chiefly we teach units rather than fundamental areas, manners of thinking, processes, and the many other objectives for which we strive.

Would it not be wise, in designating the technical divisions of the Society, and in labeling courses and committees, to use such signboards as Powering; Processing (including machinery); Sheltering and Storing; Controlling Air; Controlling Water; Controlling Heat and Light; Reclaiming? Like the term "rural electrification", these terms signify great areas of engineering activity involving processes of which units form simply a part; they do not indicate that we deal only with units, entities, end products. In our new rearrangement of index systems for the classification of literature pertinent to graduate work in agricultural engineering, we are using new terms similar to those just given. Not only do they allow more logical arrangement, but also the scheme has tended to broaden the viewpoint of those of our public who have been in touch with it.

CURRENT PHILOSOPHY NEITHER ACCURATE NOR ADEQUATE

Another factor, mentioned briefly previously, which tends to hurt rather than help our public's considerations of us, is the inaccuracy and inadequacy of a current philosophy that agricultural engineering simply is the service of mechanical, civil, electrical, architectural, and industrial engineering taken *to* the industry of agriculture, as if we were condescending to carry to agriculture something from outside it. This philosophy is of no mean proportions and consequence; it is narrowing in its influence, misleading in its inferences, and somewhat insulting both to agriculture and to engineering. Its predominance is a perfectly natural consequence, and I speak in no way derogatory of it. But you are as well aware as I that right now we are evolving rapidly toward a broader and more fundamentally sound concept of our field and functions. Surely we should take a moment to orient ourselves within the unmistakable evidences of this progress.

In the first place, we do not carry engineering to agriculture any more than engineering is carried to the automobile industry, or medicine is carried to living. The automobile industry is engineering; medicine is science within the realm of living; and agriculture itself, almost from start to finish, *is* engineering.

Secondly, all professional engineering is based upon the basic sciences of physics and chemistry, upon the exact science of mathematics, and upon a first-generation application—mechanics. From that base, specialties branch out through specialized training pertinent to the major needs of the area of the specialty. Civil engineering is the engineering of relative position, and of the construction and maintenance of general public works; mechanical engineering is the engineering of mechanisms and the materials thereof; electrical engineering is the engineering of a special field of the generation, transfer, and control of electrical energy; chemical engineering is the engineering of chemical processes within the chemical industry. Agricultural engineering is the engineering of biology.

Agricultural engineering in its true sense is as distinct from the other branches of engineering as those branches are distinct from one another. Of course there is some overlapping, and one branch draws to some extent upon another, because they are all fundamentally related divisions of a vast, all-reaching philosophy of physical and mental processes or methodology. But I cannot bring myself to believe, nor can I ask my students or our public to accept the philosophy that our field is simply a special adaptation of some of the so-called older branches of engineering as such. Surely we have many, many problems involving the end products of mechanical, civil, electrical, and architectural engineering; and there are specialists in those fields to aid us with these end products. But to see these things in any other way than simply as parts of a big picture is an illustration of the trite saying that we cannot see the forest for the trees.

Engineering is a science of recognizing problems, of analyzing them by basic analyses, of determining all the facts and coordinating them, of discovering ways and means, of executing with meticulous care and exactness, and of directing dynamically unto ultimate conclusion. In plain English, the engineer is the man who must evolve a sound working program and carry it out. Engineering deals fundamentally with energy control, transfer, and transformation; and all engineering is based on the efficiency concept. The biological kingdom is the earth's greatest realm of energy transformation and transfer. Nature made agriculture a form of engineering before we were ever dreamed of; and if we do not conceive of ourselves as an inherent part of agriculture, and if we cannot

see the really fundamental engineering processes and problems in agriculture awaiting us, it is not Nature's fault.

When we work from the inside of agriculture outward, instead of attempting to work into it from the outside, we are amazed at the opportunities offered by and the needs of the natural sciences for engineering interpretations of the fundamental engineering involved. The execution of such professional work demands the best of talent and training, and it respects the best of engineering ideals, prerogatives, and traditions.

Until more engineering faculties as groups come to the appreciation of some of these facts, I question the justice in the position that some older-line engineering factors or committees have assumed that they alone are the fair and competent judges of the curricular needs of agricultural engineering. Curricula should be results, not causes. A curriculum cannot make a field. The true field of agricultural engineering has existed for a long, long time; and the problem is to appreciate that field and to determine its curricular needs, rather than to attempt to carve out a field to fit some other curricula.

Furthermore, until more of our public acquires some of the appreciations mentioned, we may not have coming into our departments of agricultural engineering that increase we need of youths high in potentialities for leadership.

PROPER EDUCATION IS VITAL

The foregoing are basic or background considerations. Permit me now to move up for just a moment to a fundamental or two in the area of education, which, for the proper perpetuation of agricultural engineering, carries the greatest responsibility of the profession.

Of course we all agree that artisans, technicians, and professional leaders are needed in agricultural engineering. But sometimes we forget the importance of both a quantitative and qualitative balance between these groups, which is influenced by the quality of the raw materials coming to us and by how we fabricate them.

I am not so concerned about students whose capabilities or inclinations may confine them to the activities of technicians. There are a number of so-called applied courses in agriculture and in engineering in which they may gain experience and learn rules for specific applications.

But I am gravely concerned about the scarcity of the supply and about our handling of students of high leadership potentialities. They, first, are unusually capable and independent thinkers, fundamentally, and in the fundamental realms; they are searchers for new truths and relationships; and they are of powerful personalities. It is a crime against civilization to kill these men off by too narrow curricular requirements; and for this very reason we may soon see some richly endowed institutions offering such men a very fundamental training for our field. Some of these institutions are beginning to nibble at the possibilities; but they will not adopt the philosophy that agricultural engineering is simply a readaptation of the so-called older lines of engineering.

We need more students with high leadership potentialities for future leadership in agricultural engineering, which means simply for leadership in agriculture. I picture them as prospective deans, directors, administrators of great agricultural movements. Opportunity for the reality of this dream is just around the corner if we will prepare for it.

For necessary breadth, agricultural engineering education must include a just share of fundamental biology, including bacteriology, as a counterpart of the engineering fundamentals. Mere application courses in agriculture alone will not suffice. Obviously this basic training in biology is necessary for the requisite understanding of fundamental processes in agriculture; without it the agricultural engineer cannot work with other agricultural scientists on the same footing; and if we do not have this training we must remain the servants of other scientists because we have shut the door of opportunity to make our own discoveries in fundamental realms of agriculture. To leave this door open and to prepare ourselves to enter the realm beyond, is very essential to the future of agricultural engineering and to agriculture itself. Of course you will say that I am treading on the toes of other scientists, but I can name several instances where such scientists have needed and welcomed our viewpoint, just as we welcome theirs in cooperative endeavors.

Incidentally, chemical engineers are required to take from 30 to 40 hours of chemistry in preparation for their profession. Yet our own profession has been attempting to produce agricultural engineers with very little—and in some cases with no—fundamental biology.

To attain balanced, fundamental training, in both engineering and agriculture, we may better sacrifice some so-called application courses in each field than to slight the fundamentals of either area, particularly with those of our students who show real leadership possibilities. To avoid too much sacrifice, some institutions have installed 5-year curricula as stepping stones to 6-year courses; and one institution claims that it offers 7 years to assure the breadth of training it deems wise. However, the objective is not met if we use the time gained by longer curricula simply for more engineering without a corresponding increase in agricultural sciences and in the humanities.

If we could expect various departments of a large institution to institute courses primarily for agricultural engineers, we might be able to accomplish as much in four years as we do in five years when the regular run of service courses must be taken. But this is an ideal not yet easily obtainable. In any event we cannot afford to sacrifice quality for time, because we should be more interested in the quality of our graduates than in the quantity. Fifteen years from now a handful or real agricultural engineering leaders will do more for the advancement of agricultural engineering than a hundred men who must remain technicians because of limited ability and inclination. The influence of leaders spreads more by geometrical than by arithmetical progression.

The character of our service courses, which we give students not majoring in agricultural engineering, has very important bearing upon the public's considerations of us. Time does not permit me to go into this subject in this assignment. It deserves special treatment.

EVIDENCES OF EVOLUTION IN VIEWPOINT

In the time remaining we have opportunity for an illustration or two of evolution in viewpoint and in methods of approach.

When we sprang up in agriculture, we saw need for lowering costs of farm operations, a good example of which was seedbed preparation and cultivation. Agricultural engineering contributions within this area, through units and improvements thereof, have been so marked that we have not much opportunity to lower costs farther as long as present field practices are in vogue. So we have been shifting toward researches for rather distinctly new

methods which will generate from our functional position as a part of soils and crops sciences.

For some time we have been challenged by the fact that our soils constantly are becoming heavier due to tillage, and that there may be ways of processing soils to preserve better certain essential characteristics of the soil mass. Nature does that by her own processes of manipulation. Soil conservation not only means prevention of erosion by the use of units such as dams, terraces, and plant placements, but also it means prevention of internal deterioration. We may work on the outside of the soil mass to hold it where it is; then we crawl into the mass, which is full of baffling engineering, to discover ways of securing it qualitatively.

In our contributions to fertilizer-handling equipment we partially have met an emergency by improving existing units and taking them to the fertilizer-placement problem. That was the easy way of working from the outside inward. But now we find ourselves blocked by a series of unknowns. I fear that we may remain blocked until agricultural engineering carries its share of interpretations, through analyses and coordinations, of the pertinent chemistry, physics, and mechanics of plant physiology and of the aerial and terrestrial environments of the plant.

When we first attacked artificial drying of hay, we called it dehydration, because we thought the job simply was to drive off water. We poured on heat, measured the Btu's, wondered what we got, and were discouraged by costs. The attack from the outside was hot in one respect, but "not so hot" in another. Now we crawl inside the plant—yes, inside the plant cell—with the query: "What the heck?" Plant and animal cells, individually and collectively in tissue, are mechanisms of energy phenomena, more complicated than steam boilers, engines, and electrical generators. There are vitamins to be preserved; perhaps some micro-organisms to be killed while others are fostered; and the maintenance of essential elements by involved chemical processes is to be respected. Perhaps water needs to be held or added for a time—who knows? So our old problem of dehydration changes its name to a hay conditioning project which starts with the soil and ends—not with mow storage—but with the quality and cost of the milk, butter, eggs, or beef that results from the hay. And, properly, we are beginning to interest ourselves, along with medical and nutrition experts, in the completion of the cycle through the human being.

Grain drying, and long-time grain storage as part of the "ever-normal granary" theory, are similar illustrations of present tendencies to work more from the inside outward. We no longer just build this device or that in hopes that grain may behave itself in those environments. Rather, by basic analyses, we attack the problem more fundamentally by attempting to determine specifically the precise nature of stabilized grain. What is this mechanism we propose to store; what other vital or detrimental mechanisms are living within or on grain that jeopardize its safe equilibrium; and what are their secrets?

Tests to determine the cost of feed grinding and the relative efficiency of different methods were carried on quite extensively not so long ago, and their monument is a mass of valuable data and the modulus of fineness technique. But now agricultural engineers, together with animal husbandmen, nutrition men, animal physiologists, and veterinarians, are crawling inside the steer to find out what goes on there as indication of just what is best in feed processing from the standpoint of nutrition economics. Incidentally, these researchers are taking moving pictures between regurgitations; and they tell me that the sooner they get the news story and get out of the animal the better they will be pleased as regards both their nerves and their laundry bills. But casting all facetious inferences aside, this project already has yielded a wealth of valuable secrets which none of the scientists involved knew previously. Agricultural engineers were a factor in insisting upon this method of approach, in carrying out the method, and in making interpretations of the very fundamental engineering involved within the biological processes themselves. As a reward, they have a much more effective approach to the feed-processing problem than when they asked the animal husbandmen what he wanted in ground feeds. He did not know.

Just as other scientists can ask many embarrassing questions of us, so too agricultural engineers have a number of very pertinent queries that have not been answered satisfactorily regarding plants and animals and their environment. One reason is, we have a responsibility with the other scientists which we have neglected in the past—the responsibility of appreciating the really fundamental engineering within biological processes. At the winter meeting of the American Society of Agricultural Engineers at Chicago last December we had the pleasure of hearing one of our esteemed members picture some of the intricacies to which I refer. He alluded to the soil mass as a gigantic storage battery. This member is very secretive about his researches, partly because the potentialities of some of them scare him nigh unto death. Some of us who have had the privilege of attempting to understand the tough engineering he has gotten into are deeply impressed with the significance of his approach as an agricultural engineer. Incidentally, I understand that one of his theories, which was smiled at a year ago, recently has been substantiated by Koch in Germany.

We could go on and on with illustrations that agricultural engineering not only finds its gold on the surface in forms which the public sees easily, but also that we are digging deeper and deeper for that wealth of *our* gold that lies hidden in every phase of agriculture. We do this because as engineers we love to, and because as engineers it is our sacred duty to the American public. These attitudes and spirit permeate our educational philosophy, our research work, our extension activities, and our representation in industry—all factors in this Society.

INDUSTRY NOT A THING APART

If this presentation seems too academic to be of interest to those in the manufacturing industry. I fear they wrongly may be feeling lack of responsibility for agricultural engineering administration. Many of the fundamentals and attitudes I have treated herein are bound to have ultimate effects of considerable significance to industry. If colleges are to prepare men for all functions in agricultural engineering, industry must interest itself in a sound, progressive philosophy from basic considerations, be that academic or otherwise.

I have said nothing new. I have simply picked out a few old things which I consider most pertinent at this particular time, and attempted to align them in a manner that may help us organize our thinking.

No man should divorce himself from the social implications of his activities. If we will advance our progressive viewpoint in the eyes of our public, by functioning well on the basis of that viewpoint, there is no branch of human endeavor that offers more opportunity for the joy of constructive and far-reaching accomplishment than the true field of agricultural engineering.

New Horizons for Agricultural Engineers

By Dr. C. W. Warburton

THE word horizon brings a mental picture of the apparent meeting of earth and sky, a limit to visibility. With respect to knowledge we think of the horizon as a limit of perception, or with reference to endeavor and performance as the advance bounds of experience. Science is constantly widening horizons. Each new development enables us to see a little further in one direction or another—enables mankind to extend its activities with new experiences for profit or pleasure. Engineers, working in both the exploration and development fields, are constantly extending our horizons of knowledge and experience.

As a basis for a discussion of new horizons, it may be well to consider for a time how these horizons have been extended in the past one hundred years. Perhaps a review of the progress we have made in pushing back horizons during this period will give us a starting point for hazarding a few guesses as to the directions in which we may widen our view in the future.

Our progress in the mechanical development of agriculture has for the most part come in the last one hundred years. For instance, a hundred years ago farmers were still harvesting grain with practically the same methods and the same equipment their ancestors had used for centuries. In AGRICULTURAL ENGINEERING for March there appeared a reprint of an article originally published in a report of the Department of Agriculture for 1866, in which it was stated that the harvesting machinery for grain in 1820 consisted of a cradle costing $2.50, a rake costing 25 cents, a flail costing 50 cents, and a fan to clean the grain costing $1.00, a total of $4.25. Contrast that outlay for mechanical equipment for grain harvesting with today's requirement of the binder and threshing machine, or with the combined harvester with a tractor to furnish power. You will recall that within the past few years we celebrated the one-hundredth anniversary of the invention of the reaper by Cyrus McCormick, the first step in the development of modern harvesting machinery. Much the same situation existed a hundred years ago with other types of farm machinery. We are just now, for instance, celebrating the centennial of the steel moldboard plow.

The adoption of large-scale and labor-saving machinery on farms has not, in general, caused large displacement of farm labor, but rather has been forced on the farmers by scarcity of farm labor, or what farmers believed to be its high cost. A hundred years ago about 80 per cent of our people engaged in gainful occupation were on the farms, and only about 20 per cent in cities and towns. Now that proportion is almost reversed, with only a little over 20 per cent on the farms. In other words, one hundred years ago it took the work of four persons on the farm to produce enough for themselves and their families and for one family in the city. Now one family on the farm produces enough for itself and four city families.

The movement from the farm to the town was under way one hundred years ago. In the old Farmers' Almanac for 1837 a New England farmer bewails his difficulties in getting farm labor, and tells how all of his five sons had become shoe cobblers. Even old Pat M'Coulter who had been a laborer on this farm for many years, and whose skill in swinging a scythe or a cradle in the grain fields was described as "simply like walking on air", Pat, too, had been foolish and turned cobbler. The making of a pair of shoes brought in 25 cents, and it was no difficult job to make a dozen pairs a day; so, in the words of the writer of 1837, "money, much money, comes for shoe pegging. Yankees love money, and will leave farm and all to obtain it." Perhaps it was conditions such as these that produced the urge for many of the mechanical improvements in farm implements which started about 100 years ago.

At about this time, our people were pushing back their geographic horizons toward the West. Hardy pioneers, adventurers, and trappers had long before pushed across the Alleghenies into Ohio, Kentucky, and Tennessee, and 100 years ago had reached Illinois. You will recall that only very recently Chicago celebrated the centennial of its founding. The first railroad in the United States was started 110 years ago. With the pushing of railroads into the Ohio Valley and westward came a great surge of settlement, with the broad level fields of the prairies offering opportunity for the efficient use of large-scale machinery.

One hundred years ago our wheat was mostly produced in the eastern seaboard states and Ohio, extending over into Indiana and Illinois. The area of heaviest production then was western New York. Sixty years ago the principal wheat-producing sections were Ohio, Indiana, southern Michigan, western Illinois, southeastern Minnesota, and the Sacramento Valley in California. The development was just getting well started in eastern Kansas and Nebraska. It was only with the war-time urge for wheat production, and the development of the most modern tillage, seeding, and harvesting machinery, that wheat production became important in the southern Great Plains area, much to the detriment, as events have proved, of that region.

One hundred years ago it took nearly 60 hours of man labor to produce an acre of wheat. Forty years ago in the central winter wheat belt this had been reduced to a little less than 9 man-hours, while now in the Great Plains only a little over three man-hours per acre are required, although with weather conditions, such as have prevailed in that area in recent years, even that is far too much for the results obtained. The figure does show, however, the great strides which have been made in reducing the man-hours necessary to produce an acre of wheat. It would seem we have about reached the limit of our horizon in this direction, and that further advances must come from the plant breeder, the pathologist, and other technicians, although the engineer no doubt has a part to play in the development of better tillage methods and the conservation of soil and water.

In crops other than small grains, reductions in man-hour requirements have been marked, though not as spectacular as with wheat. In seventy-five years, according to the Department of Agriculture, man-hour requirements for corn have been reduced from about 34 per acre to 7, with some possibility for further reduction.

Many of us can remember when the principal use of the tractor was to pull and operate the itinerant threshing

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An address before the annual meeting of the American Society of Agricultural Engineers at the University of Illinois, Urbana, June 23, 1937.

Author: Director, Agricultural Extension Service, U. S. Department of Agriculture.

rig. In quite recent years, however, the substitution of the tractor for horse and mule power on the farm, plus the almost universal use of the automobile and truck for road transportation and city hauling, have created some real economic problems by releasing for other uses grass, oat, and corn land formerly needed to feed horses and mules in both city and country.

Cotton is the one important field crop which still requires many hours of man labor for its production, although even with this crop the man-hours required in some sections of Texas are only about one-half the requirements of 75 or 100 years ago. The major labor requirement in cotton production is for picking. Much progress has been made in recent years in the development of mechanical cotton pickers, with grave threats to the labor situation in the South, if and when one is developed that is efficient and economical. While we are not inclined to question the benefits that would come from the lessening of manual labor in the production of cotton, it is difficult to perceive just what might be the result of the general adoption of mechanical cotton pickers. The development of the cotton gin, invented by Eli Whitney in 1794, made possible the expansion of cotton production in the South, followed quickly by the large development of cotton mills in New England. It is only in quite recent years, however, that we have realized the necessity for improvement in cotton-ginning operations, and the great possibilities for improving cotton fiber and increasing returns to producers through efficient gin operation. Pioneering research in this field has been done in recent years by the Department of Agriculture, the Bureaus of Agricultural Engineering, Agricultural Economics, and Plant Industry cooperating. The last two years have seen a wholly new development in agricultural extension work in the employment, by several of the principal cotton-producing states, of extension specialists in gin operation, who carry the results of the research at the Stoneville laboratory back to the gin operators throughout the South. Last year and this year training schools for these specialists were held at the Stoneville laboratory to familiarize them with the research conducted there. Here is a real opportunity for extending an engineering horizon.

"THE ADOPTION OF LARGE-SCALE AND LABOR-SAVING MACHINERY ON FARMS HAS NOT, IN GENERAL, CAUSED LARGE DISPLACEMENT OF FARM LABOR, BUT RATHER HAS BEEN FORCED ON FARMERS BY THE SCARCITY OF FARM LABOR"

Chemistry is so closely related to engineering that it is perhaps worth while to note what has already been done through chemical engineering research in cotton, particularly in the utilization of cotton seed. Even as recently as fifty years ago cotton seed was considered a necessary nuisance. At one time state laws were passed forbidding the dumping of cotton seed in rivers and streams. Even as recently as 30 years ago many Southern farmers were using cotton seed for fertilizer. Less than 50 years ago only about 2,000 tons of cotton seed were used for oil extraction. By 1927, however, over 6,000,000 tons of cotton seed were processed. Now, not only is there enormous use of cottonseed oil, but the cake resulting from the extraction of the oil is very largely used for livestock feed and fertilizer, the linters for upholstering fiber and cellulose, the hulls for packing and insulating material, and to some extent for livestock feed. Now, the only waste material in the cotton plant is the stalk, and experiments are under way looking toward either the use of cotton stalks or the whole plant harvested by machinery for the manufacture of cellulose.

Examples of chemical engineering development in the agricultural field might be multiplied many times, but I will mention only one other, soybeans. Introduced many years ago from China and Japan the soybean remained until about the last decade as a minor crop used for green manuring or occasionally for forage. Within a comparatively few years it has now stepped into a position of major importance in several of the corn belt states. The Department of Agriculture is cooperating with these states in establishing a research laboratory at the University of Illinois under the provisions of the Bankhead-Jones Act, to study the soybean and to develop new and improved uses. While I can not go as far as some of the enthusiastic chemurgists in predicting that chemistry will solve all the ills of agriculture, what we have seen in the utilization of cotton seed and soybeans, as well as many other products that might be cited, gives us faith that we are a long way from the limits of our horizon in the chemical engineering field.

Engineering accomplishments, the development of tillage and harvesting machinery, and exploits of the chemical engineer such as those I have just cited, sometimes cause us to lose sight of what engineers have done for agriculture along other lines. The engineer is a prime factor in the construction and operation of irrigation works so essential to the most efficient use of our arid and semi-arid western states, and in the drainage of wet and boggy lands in the Mississippi Valley. In both fields engineers have sometimes pushed the horizon too far, being intrigued with the possibilities of putting on or taking water off land without regard to the agricultural value of that land when irrigation or drainage work was completed, or whether the engineering costs might be far in excess of the producing capacity of the acres watered or drained. They should not be condemned too severely, however, nor should we forget the many fine things that they have done in these fields. Automobile wrecks usually are due, not to the mistakes of the engineer, but to the enthusiasm or the reck-

lessness of the driver. Similarly, failures of reclamation or drainage projects result usually from too enthusiastic promotion rather than bad engineering. Irrigation engineers, in cooperation with agronomists and other plant scientists, can create new horizons by further research to determine the most efficient use of irrigation waters.

Until very recently our horizon in the field of soil conservation was very limited, if we had any horizon at all. Engineers were among the first to recognize the need for saving our soil and for many years, particularly in the southeastern states, have been building terraces to prevent soil losses. Soil conservation and erosion control are so prominently in the public eye just now that I shall discuss the subject only very briefly. It is fortunate, however, that there is now a general recognition that soil conservation is not simply an engineering problem, but that if we are to conserve our soil for future generations we must have the best thought not only of the engineer, but of agronomists, foresters, farm management specialists, and, in fact, workers in practically every field of agriculture. Just a few days ago Dr. Hugh H. Bennett told me of seeing irrigated farms in the West where irrigation was still being done straight down the slope with a heavy loss of the most fertile top soil resulting from every application of water, although contour irrigation has been recommended for years. Such mistakes are still far too common.

The introduction of the combined harvester into the humid areas created new problems for the engineer in the development of effective drying and storage facilities for damp grain, with other new storage problems developing in the expansion of the soybean acreage, and the use of the combine for harvesting that crop. If Congress passes legislation to carry into effect Secretary Wallace's "ever-normal granary" plan, we may have a very considerable increase in the demand for farm storage with possibilities here for engineers to push back horizons in working out new designs for efficient and economical storage facilities.

Until now my discussion has related almost wholly to field operations. The engineer has just as important a place in assisting the farmer plan his farm structures, his barns and feed lots, and most essential of all, his home. The engineers of the land-grant colleges, in cooperation with the Extension Service and the Department of Agriculture, have done fine work in getting out plans for farm houses and farm buildings, and making these plans available through county agents to farm families. As yet, however, they have had comparatively little influence on either the construction or the remodeling and repair of farm structures. It is still a far too common practice for the farmer to build his barn wholly according to his own ideas, which may or may not result in an efficient and economical structure, or to leave the planning of his home to a small town carpenter. We have only made a beginning when we have helped the farm family to perform farm operations more efficiently, and to increase farm income. The really important end of all our work, it seems to me, should be to make farm life more comfortable and satisfactory. In the field of farm and home planning and equipment, our horizons are still very close to us.

As we have become soil conservation conscious in recent years, so have we also become electricity conscious. More miles of rural electrification lines have been built and electricity has been made available to more farm homes in the past two years than in any previous similar period. Apparently we are just at the beginning of great development in this field, with its possibilities not only of making the farm home more satisfactory through better lighting and the use of labor-saving devices, but making the farm operations more efficient through the use of electric motors in operating small power machinery. I am told that something like 200 uses of electricity on the farm have been developed. Here again is an opportunity for engineers working with other agricultural specialists to push back the farm horizon. Again, however, a word of caution seems desirable that we do not let our enthusiasm for electrical developments on the farm lead us into advising farm families to buy electrical equipment which will not produce adequate return, either in satisfaction, saving of labor, or increased efficiency of operation. So far the use of electricity on the farm is limited very largely to uses in the farm home and around the farmstead. Perhaps a new horizon for engineers lies in the development of the uses of electricity in field operations, possibly some day replacing the gas engine, as the gas engine has to a large extent replaced the horse. I am not enough either of an engineer or a prophet to hazard a guess on possible developments along this line.

In our enthusiasm for the use of electricity on the farm we should not forget that for a good many years to come many farm homes probably will have to depend on other means of lighting and of operating small machinery and equipment. I am not certain that it is the job of the engineer, but I believe someone could render a real service if he would write a short common sense extension bulletin on kerosene lamps, and another one on the efficient operation of heating and cooking equipment. Sometimes we are so impressed with the possibilities of great advances which may be made by a comparative few that we lose sight of the shorter steps which we might help the great mass of our people to make.

One who is better informed on engineering that I am no doubt could talk all day on what engineering has done and can do for the American farmer. I have a very great admiration for what you and your fellows have accomplished, and the further things you can and will do. I congratulate you most heartily on your past performance and the possibilities that the future holds for you.

Drop Inlet Soil Saving Dams

By E. R. Jones

EROSION control contemplates reduction of the runoff as much as possible by absorption of the rainfall, and the passage of the rest as runoff to its ultimate destination with as little erosion as possible on the intervening land. The engineer is concerned with both of these phases of control. With the forester, the soil technologist, and the agronomist, he shares the former field. The safe conduct of the inevitable runoff is more exclusively an engineering problem, both present and future. So long as rain falls, there will be some concentrated runoff at some season of the year. It occurred to a notable degree during the ages that preceded the axe, and it must be expected, at least to a like degree, in the days that follow the plow.

To reduce runoff, the engineer maps the watershed and delineates for the forester the steep headwater slopes for reforestation. To keep it dispersed, he seeks the help of the soil technologist and the agronomist, and establishes for them the contour lines that are the bases of contour farming, strip cropping, and better vegetative covering. To carry it safely after it inevitably concentrates, and to induce further absorption, he designs, constructs, and maintains low-gradient terraces across the slope. To let it run down the slope, he provides a wide, smooth, tough, sodded run, which is the most resistant vegetative covering. But where it has broken the sod, and a gully has developed, with a vertical overfall at its advancing lip, and where all efforts at resloping and resodding have failed or seem foolhardy, he designs a permanent soil-saving dam to save the soil by making it safe for seed.

The Menace of the Gully. Of the many necessary engineered operations, stopping the big gully before it does any more damage is probably the most spectacular. Picture a gully with a 10-ft vertical drop at its lip, which is advancing from 50 to 500 ft a year through a comparatively level watercourse. Unbridled, it threatens to cut a gash to the head of the watershed and to branch up its sides. The borders of the basin are its ultimate bounds. Every acre in the watershed, regardless of its vegetation, is menaced by the intruding gully and its budding branches. If the land is worth saving, and, if the cultural and vegetative treatment of its slopes is to survive, the advance of the gully must be stopped. Otherwise the most excellent practices on the tributary slopes are doomed to ultimate defeat. To this extent the repulse of the downstream gully is a more strategic defense than the treatment of the upstream slope.

Some watersheds have been mutilated so badly, and the gully branches have advanced so near to the borders of the watershed, that there is not enough agricultural land left to warrant a major structure, protected as earth bottoms have to be by secondary structures to reduce the excessive gradient. There forestry is the best land use, and reforestation at a minimum expense is the only remedy.

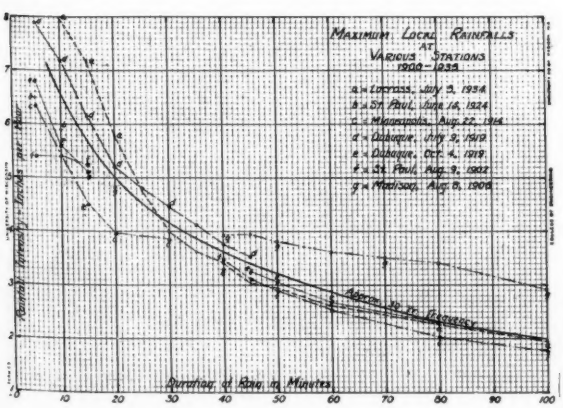
In other cases, the watershed is small and the vertical drop at the lip of the advancing gully may be only 3 or 4 ft. There, by sloping the vertical overfall to a 10 per cent slope in all directions, and sodding it by hand, the sod cover may be reestablished. Vigilance in the detection and repair of broken sod is the price of its maintenance. A single break in a sodded run creates an overfall which starts a washout that may undo the entire treatment. Where both the cost of sloping and the risk of sodding are great, a permanent structure is the economical solution.

Farmers have become discouraged with temporary check dams made of woven wire, or layered brush wired down with meticulous accuracy. Such dams create an overfall which causes their own undermining and destruction. When they finally wash out or decay, gone is the soil that they have saved, and the vegetation they have fostered during the short period of their existence. For stream-bank protection, brush wing-dams, and rows of posts without any wire at all, render valuable service. Success is due to the simple fact that the sediment dropped back of these deflecting porous dams reinforces the base of the protected bank and does not cause an overfall in the main stream. Extended across the stream, such porous dams soon become non-porous, hold back a head of water, and cause silting in the main stream. The higher they build up the overfall by such sedimentation, the more they hasten their own destruction by undercutting.

Permanent Soil-Saving Dams. The purpose of a soil-saving dam is to collect the runoff above a spillway, through which it can fall without damaging the soil. The five types are shown in Table 1. For all of them the requirements are:

1 A water-tight dam
2 A spillway of ample capacity
3 An apron below the spillway to bear the impact of falling water
4 A material that is everlasting
5 An intercepting dike to divert the runoff and a channel to deliver it to the spillway
6 A safe gradient below the apron
7 A public or private benefit exceeding the cost of construction.

For a few years there may be a pond on the upstream side of the dam. But eventually the pond is filled by sedimentation, and the alluvial plane delivers the water to the spillway, which remains forever as a conduit through the dam. Ramser's runoff curves, adapted by Minshall, afford


Maximum Local Rainfalls at Various Stations 1900–1935
a = Lacrosse, July 9, 1934
b = St. Paul, June 14, 1924
c = Minneapolis, Aug. 27, 1916
d = Dubuque, July 2, 1919
e = Dubuque, Oct. 4, 1919
f = St. Paul, Aug. 9, 1907
g = Madison, Aug. 5, 1900
Duration of Rain in Minutes

Presented before the Soil and Water Conservation Division of the American Society of Agricultural Engineers at Chicago, December 4, 1936.

Author: Professor and chairman of the department of agricultural engineering, University of Wisconsin. Mem. ASAE.

a basis for determining the necessary spillway capacity for the maximum 30-year runoff, which ranges from 5 in per hour for a steep 10-acre watershed to ⅝ in per hour for a 2800-acre watershed of 5 to 15 per cent slope.

TABLE 1 THE RIGHT SPILLWAY FOR THE RIGHT PLACE

Type	Head	Watershed	Comparative Cost Earth fill	Spillway
Drop inlet	High	Large	High	Low
Notch spillway	Low	Small	Low	High
Head flume	High	Small	Low	High
Head spillway	Low	Large	Low	High
Sod hump	Very low	Very small	Very low	Very low

Counting the Structures. An average of two permanent structures per square mile was the preliminary estimate of the number of permanent structures needed to stop dangerous gullies on 6,000 sq mi of the unglaciated area in western Wisconsin. A more detailed erosion survey begun by the ECW technicians in eight counties in 1934, and continued by the U. S. Soil Conservation Service in Grant County in 1936, indicates that the preliminary estimate was conservative. On 148.5 sq mi covered by these surveys there are 325 sites where gully control structures are both necessary and timely, with two-thirds of them in deep earth and one-third on rock bottoms. At 288 additional sites where structures are necessary to stop further destruction, the gullies have encroached so far upon the borders of the watershed that the optimum time for control is past, and the economic value of structures is questionable. There the ratio of earth bottoms to rock bottoms is approximately reversed.

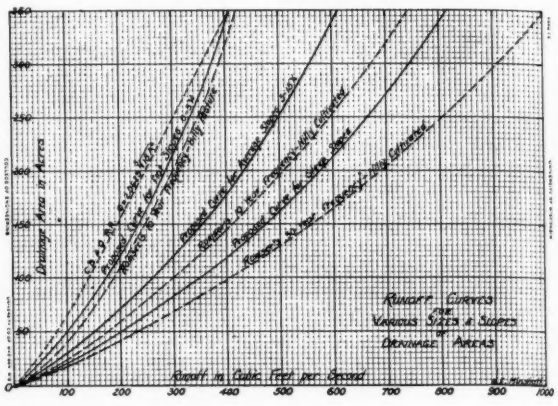
On 62 sq mi, representing 301 structures, a total of 3586 cu yd of concrete and 4600 cu yd of masonry are required in the spillways, and 167,000 cu yd of earth fill in the dams and diversion dikes. On this same area over 300 additional small but active gully heads were found and classified as susceptible to sloping and sodding, the benefit of a doubt being given to the success of that method of treatment.

By 1936 exclusive of innumerable sodding treatments, the number of permanent structures operating in Wisconsin has been increased to more than 1,000. While several of them have been given minor repairs, only six have failed completely. Two of them were drop inlets. In each case, the water made a hole through the dam, undermining the barrel and letting the riser tip over on its side. The other four failures were head spillways which failed, chiefly because of their buoyancy. In all six cases, neglect in tamping the earth carefully close to the concrete was a factor. More than half of the minor failures, where part of the fill was lost, can be traced to this same cause. The job foreman must watch the tamping of the earth just as closely as he watches the pouring of the concrete.

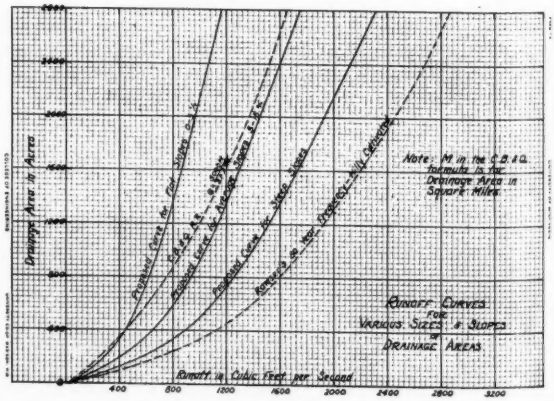
TABLE 2. TYPE OF STRUCTURES REQUIRED. WISCONSIN PRACTICE

The performance of ECW erosion control camps. Cost of concrete and masonry computed at $20.00 and earth fill at 30 cents per cubic yard in each case

Types	9 camps 6 months 1933	8 camps 6 months 1934
Drop inlet	200	144
Concrete notch	35	63
Masonry notch	37	24
Head flume	30	22
Head spillway	44	33
Total	346	286
Total concrete, cu yd	6872	5169
Total masonry, cu yd	938	1877
Total earth in dams, cu yd	383,304	295,751
Acres in watersheds—		
Total	34,560	44,294
Average	100	154
Cost of structures—		
Total	$271,191	$229,645
Average	780	800
Average cost per acre	7.80	5.20



Stopping the Active Lip. A soil-saving dam does not purport to fill the gully below the dam. There the damage is already done, and, except for vegetative improvements and intercepting dikes to divert the lateral runoff into the pond above the dam, must be endured. The purpose of the structure is to stop the advance of the gully above the dam. The filling of the pond with silt is a mere incident thereto, even though the surface of the pond, when silted full, may become valuable pasture or hay land. A dam placed below the junction of two gullies will stop both



of them, if the inlet is high enough to drown the lips of both, and diversion dikes are placed above both to hasten the silting of the pond by directing the runoff to the peninsula between the two branches.

Highway culverts can be converted into soil-saving structures by the addition of a drop inlet at their intakes. There the earth dam and the barrel of the culvert are already built. In many cases a gully has been started in valuable land above the highway by the overfall of water upon earth to reach a depressed culvert. A raised inlet to permit the water to fall on an erosion-proof concrete apron is an inexpensive, but effective remedy. Unless the highway fill is well made, it is necessary to retamp the upstream portion.

Drop inlets and head spillways lend themselves well to use as highway culverts. The saving through combined utility exceeds the extra cost of the heavier spillway construction and the wider earth fill. Every farm and highway culvert in the watershed above the lip of an advancing gully is benefited directly or indirectly by the necessary structure, in the construction of which it is good business for several farmers and the town or county to participate. The unjust burden may be too heavy to be carried alone by the one farmer on whose land the gully happens now to head.

Each type of soil-saving dam has characteristics peculiar to itself, and worthy of separate discussion. Unless otherwise noted, the recommendations harmonize with the 1935 Wisconsin Erosion Control Handbook by Neal Minshall.

(To be continued)

Better Light Available for the Farm

By L. C. Porter

TREMENDOUS advance has been made in lighting during the past few years. Light sources have been greatly increased in size and efficiency. Better equipment has been developed to go with them, and new and improved methods of utilization have been put into practice. A new science of seeing has been born. This science is proving a vital connection between light and health. No longer is the use of artificial light merely a question of the selection of the proper lamp and its location—where it can be used most effectively. Rather, it involves the formation of a technical basis of illumination and the formation of fundamental criteria. Principal among these are *visibility* and *comfort*. The basic principles of visibility are already established. We *know* what levels of illumination are required to perform various tasks at maximum speed; we *know* the effects of contrast of light and shade; we *know* the effects of color, the reduction in visibility due to glare, etc. All of those things have been accurately measured and evaluated.

Not so much is known about comfort. Dr. Luckiesh in the lighting research laboratory of the General Electric Company, is developing data which shows how much nervous energy is used up by our eyes—nearly one-third. It is surprising how much physical fatigue may be caused by uncomfortable lighting. The number of times one blinks under different lighting systems is being recorded and is evidently a rough measure of the relative comfort or discomfort caused by lighting. Light has also been proved to affect the rate of heart beat. All of these data are being used in connection with the development of better seeing conditions.

During the past ten years there has been a steady increase in the number and sizes of electric lamps available. Steady increases have been accomplished in the efficiencies of these sources. Let us take just one lamp as an example. Ten years ago the 60-watt Mazda lamp emitted 666 lumens of light. Today it gives 828. Ten years ago this lamp sold for 30 cents. Today it costs 15 cents. It is estimated that the latest improvements in household types of Mazda lamps will save the public $60,000,000 annually by giving them more lumens for their money than they ever had before.

To the regular line of Mazda lamps have been added in the last few years new sources: sodium lamps, high-intensity mercury lamps, ultraviolet lamps for the maintenance of health, infrared lamps for the relief of pain, photo-flash and photo-flood lamps for photography, fluorescent lamps generating colored light 200 times more efficiently than heretofore, 5000-watt lamps for deep-sea diving service, and 50,000-watt lamps for floodlighting large areas. In the laboratory a light source has been developed that has a brightness comparable to that of the sun. Lamps are available to force the growth of plants, to attract and kill insect pests, to sterilize foods, ripen fruit, increase production and reduce disease in dairies and poultry flocks. In fact, there is practically no phase of human activity that does not use artificial light in some form or other.

Walk through the centers of any of our great cities at night, and truly it is evident that the darkness of night has been banished. So also have our modern homes come out of the night. It is inconceivable that this great advance in living will be limited to the city. The man and his family who live on a farm are just as much entitled to the advantages of better light for better sight as his city brother. Rural electrification is rapidly making this possible. It will come to the farm home much more easily and more cheaply than it has in the city. The farmer today can take advantage of all the experimental work and development that has been tried on his city brethren. Furthermore, new types of lighting fixtures embodying the principles of good lighting at minimum cost have been developed for the farm field. As agricultural engineers and leaders in the farm field, we not only have a great opportunity but really a sacred duty to acquaint the farmer with latest lighting practice and help him select modern, efficient, and economical equipment.

There is a wealth of educational material available to assist in doing this. This year's report of the ASAE Committee on Uses of Electric Light in Agriculture lists such aids and tells where and how to obtain them. Let us take advantage of our opportunity and help the farmer "out of the night," to a better, happier, and more prosperous living through better light for better sight.

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers, at Urbana, Illinois, June 23, 1937.

Author: Illuminating engineer, General Electric Company. Mem. ASAE.

Tractor Fuels in Relation to Tractor Operating Costs

By F. W. Duffee

IN PREPARING this paper I have kept in mind the farmer's interest and viewpoint solely, and the discussion will be confined almost entirely to the Otto-cycle type of engine. The data relative to fuel prices will be tank wagon prices in the Madison, Wisconsin, area. Also this is not intended as a complete discussion of this very important matter.

The most important items to be given consideration relative to a type of fuel to be used in tractors seems to me are these, and in about the order the farmer would consider them: (1) first cost of tractor, (2) total yearly operating cost over a period of years of fuel, oil and repairs, and (3) convenience.

What are the things about fuels that will especially interest us as users? The following seem to be the factors, but not in the order of their importance, however: (1) ease of starting; (2) anti-knock characteristics; (3) economy, that is, how much power can be obtained from a gallon of the fuel; (4) tendency of fuel to produce oil dilution and sludge with possible excessive engine wear; (5) whether or not the fuel is taxed or tax-free, or tax-refundable, and (6) convenience of use.

All of these certainly are in conscious consideration in the user's mind with the possible exception of the anti-knock rating. We know that he will be interested in this, even though he is not conscious of it, as higher anti-knock ratings will permit of high compression ratios, and this means more power and higher efficiency from the engine.

Several of the items above are directly related to volatility, that is, ease of starting, dilution, and convenience of use. A low volatility fuel such as distillate means that the operator must start on gasoline. It also means that he must give greater attention to the matter of engine temperature control, more frequent changing of oil, etc.

Fig. 1 shows a summary of the average distillations of fuels sold in North Dakota. These data are taken from Bulletin 48, page 54. (There is an optical illusion in Fig. 1, and in studying these curves I wish to emphasize the importance of reading the spacing vertically on the sheet, and not vertically between the curved lines as is the natural tendency). There has been a very marked increase in volatility of gasoline over the last ten years, more especially during the last five years. Unfortunately I was unable to find data showing what has happened to the volatility of kerosene and distillate fuels over this same ten-year period. I have found some definite evidence of improvement, but not enough to warrant specific presentation.

The data in Fig. 2 are also taken from North Dakota Bulletin No. 48. The lowest curve shows the upper limits for summer specification gasoline permissible in North Dakota. The curve listed as having the lowest initial boiling point is a special fuel for tractor operation developed, I believe, to be tax-free, but still to have a fairly good volatility. The next curve, the one listed as having the lowest end point is the one with the lowest initial point, but it has a higher boiling point, and probably is representative of the average grade of good tractor fuel of the distillate type. The next curve up, the one listed as having the highest end point, was the least volatile fuel which we could definitely identify as being sold as a tractor fuel. The top curve shows the volatility of the least volatile fuel listed in the table. This is indicated on the chart as a tractor fuel, with a question mark. I mean by that that a farmer *might* buy it for tractor fuel because it probably is a little cheaper than other fuels, or he might have it *sold* to him as a tractor fuel by an unscrupulous dealer. I feel sure that most Otto-cycle engines would definitely be in trouble if they were operated on this fuel.

Another point that I should like to emphasize is that the spread between the upper limit for summer gas and the most volatile distillate is less than the spread between the tractor fuels themselves, and infinitely less than the spread between the most volatile distillate type fuel and the least volatile distillate. In other words, there is an enormous variation between the volatilities of different grades or brands of distillates.

Fig. 3 is prepared from the specifications of one refiner's fuel. It did not seem feasible to undertake to establish averages here. The chart itself is explanatory, showing the specifications for 1936 summer gasoline, tractor distillate with an octane rating of 30 plus, and kerosene with an octane rating of 0 to 10. The two low-volatility fuels have essentially about the same volatility. The tractor distillate, however, is slightly superior, and it has an infinitely better octane rating. These fuels are usually produced under widely different conditions. The kerosene usually being a straight distillation from the original crude, whereas the tractor distillate is distilled after the cracking process. The principal advantage of kerosene over distillate would probably be its more widespread distribution and availability, but wherever the tractor distillate is available, it obviously would be a much superior tractor fuel and ordinarily would sell at a lower price. This, therefore, would indicate that, generally speaking, we would recommend distillate in preference to kerosene.

Fig. 4 shows the horsepower-hours per gallon of fuel, for the rated load at the belt, of tractors as tested at Nebraska. The chart represents the average of the ten highest tractors tested in the last three years, the exception being the two tractors tested on gasoline having an octane rating of 68-70.

It is probably worthy of note here that Diesels and the

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Author: Professor of agricultural engineering, University of Wisconsin. Mem. ASAE.

high-compression Otto-cycle engines would show up relatively better still at the less-than-rated load.

As users, we are interested not in horsepower-hours per gallon, but in the cost per horsepower-hour. Fig. 5 gives this analysis. The prices for fuel given in this chart were the Madison, Wisconsin, tank-wagon prices in effect December 1, 1936. The gasoline price is given without the state tax, as in Wisconsin the state tax is refundable on gasoline used in farm tractors.

Fig. 4 indicates that the high-compression gasoline engine is a more efficient unit from the standpoint of thermal efficiency, but the lower price of distillate—even though burned at a somewhat lower thermal efficiency—shows a much lower cost per horsepower-hour for the distillate-burning tractors. Specifically the fuel cost per horsepower-hour for the distillate tractors is 27.8 per cent less than the high-compression, gasoline-burning tractors and 34 per cent less than the average of the ten highest using ordinary compression.

There are two parts of the bar for the ten highest operating on regular gasoline. The right-hand bar (B) is figured on regular house-brand gasoline at 12.8 cents per gallon. The other (A) is figured on third-grade gasoline at 11.8 cents per gallon. This is done because I was unable to determine definitely from the Nebraska tests which grade of gasoline was used. In order to avoid criticism, I am showing the results calculated on both prices.

Again returning to our original outline of the factors involved in the total annual cost of operating a tractor, I repeat that these costs are fuel, oil, and repairs.

It is quite generally agreed that with Otto-cycle engines there will ordinarily be more oil dilution with the low-volatility fuels such as distillate than with gasoline. We were originally of the opinion that this dilution was a serious hazard, and it has always been a common practice to recommend very frequent changes of the oil where distillate was used, and to recommend much less frequent renewal with gasoline. If there is any analogy between this dilution problem and present-day recommendations of much lighter oils for tractors, as well as automobiles, it would seem to me that this particular phase is not so important as we originally believed. In a recent discussion of this subject by one of the research engineers of the General Motors Corporation, I learned that recent investigations on automobile engines indicate that very light oils—even SAE No. 10 or SAE No. 10W will lubricate an automobile satisfactorily under any and all conditions, even at excessively high speeds. As I recall this discussion, the principal and only objections to these very light oils was excessive oil consumption under continuous heavy-duty conditions, or under hot-weather operating conditions, and that the principal and only reason for using heavier oils was to reduce oil consumption.

Whether or not this principle has been demonstrated equally well for tractors, I am unable to say at this time. Neither am I prepared to say whether a heavier oil, say, an SAE No. 30 diluted somewhat with unburned fuel would still have lubricating qualities the equal of, let us say, SAE No. 10 or SAE No. 20. But investigation along this line is suggested. We know that there has been great improvement of piston and cylinder material; in carburetion and manifolding; that ignition is better; and that the spark-plug location is in a more strategic point. We know also that there has been a great deal of development in automatic temperature-control equipment of the engine, thus insuring a uniformly high operating temperature which is important for distillate.

There has also been some development of crankcase ventilation for tractors. Operators are becoming better in-

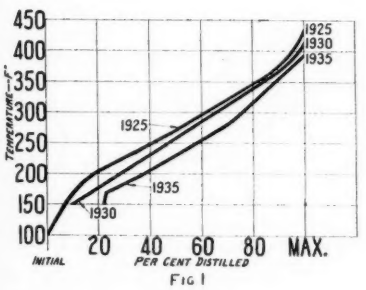
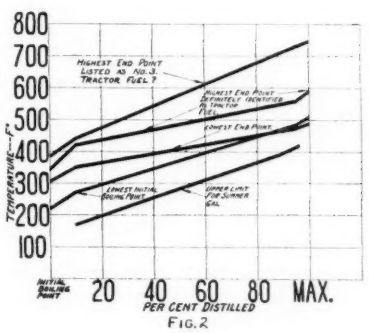


FIG 1


TEMPERATURE—F°
HIGHEST END POINT LISTED AS NO. 3 TRACTOR FUEL?
HIGHEST END POINT DEFINITELY ESTABLISHED AS TRACTOR FUEL
LOWEST END POINT
LOWEST INITIAL BOILING POINT
UPPER LIMIT FOR SUMMER GAS
INITIAL BOILING POINT
PER CENT DISTILLED
MAX.
FIG. 2

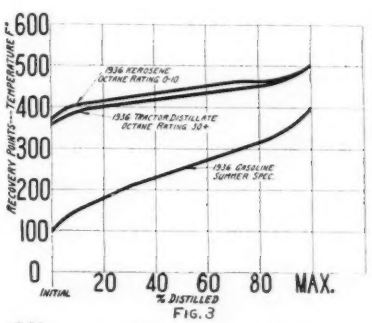


FIG. 3

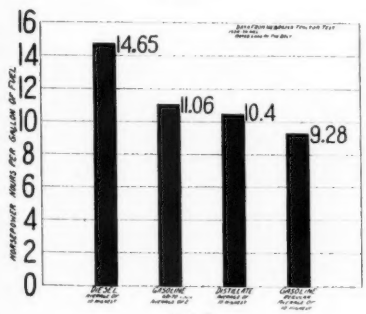


FIG. 4

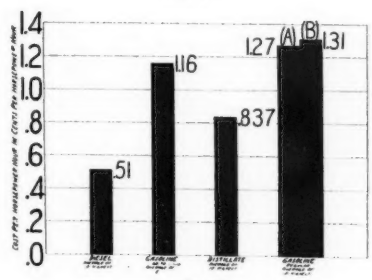


FIG. 5

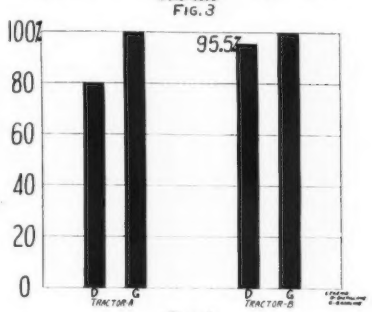


FIG. 6

FIG. 1 THIS SHOWS THE IMPROVEMENT IN THE VOLATILITY OF GASOLINE. FIG. 2 A COMPARISON OF VOLATILITY OF LOW VOLATILITY FUELS AND GASOLINE. FIG. 3 VOLATILITY OF 1936 FUELS PRODUCED BY ONE REFINER. FIG. 4 HORSEPOWER PER GALLON OF FUEL. FIG. 5 COSTS PER HORSEPOWER-HOUR IN CENTS PER HORSEPOWER-HOUR. FIG. 6 EFFECT OF FUEL ON MAXIMUM HORSEPOWER

formed as to how to handle properly the tractor operating on distillate. All of these things, it seems to me, tend to minimize or at least reduce greatly the trouble from dilution which we have had in the past.

Just what the final answer is, I am not prepared to say. I believe we violate no confidence, however, when we report that one investigation of a limited nature tended to indicate that there was no difference in repairs on tractor engines in areas where distillate was used almost exclusively, as compared to another where gasoline was used extensively. I should like to suggest that this particular point would represent a splendid field for some co-operative research, that is, the gathering of specific, accurate data over wide areas, and by several companies co-operating, that would tend to answer definitely this question of whether or not the repairs for an engine are greater when distillate is used than when gasoline is used. I believe it is true that distillate is more prone to produce sludge in the crankcase than is gasoline. I assume, however, that crankcase ventilation plus a good filter will tend to minimize this trouble.

High compression ratio means more power out of the same unit and hence a lower cost per horsepower-hour of the engine; also a straight gasoline burning engine is simpler as to manifold design and fuel tanks than a kerosene-distillate-burning engine, which also will tend to reduce the cost somewhat. First cost is an important factor in the user's consideration. A specific illustration of this effect of the maximum power upon first cost is shown in Fig. 6. Tractor A retails for approximately $1000.00 f.o.b. factory. As a high-compression, gasoline-burning tractor the initial cost per horsepower is $24.10, and as a distillate-burning tractor it is $29.90, or 24 per cent more per horsepower-hour as a distillate-burning tractor. Tractor B which does not show such a large difference between the performance on distillate and gasoline would naturally show a lesser difference in cost per horsepower.

CONCLUSIONS

The following conclusions are presented for Wisconsin conditions where the state tax of 4 cents on gasoline is refundable:

1 Where uniformly steady loads equalling or exceeding 60 to 70 per cent of the maximum horsepower of the engine prevail, use light straw-colored distillate of good grade having a maximum or end point of not over about 525 F (degrees Fahrenheit). These recommendations would apply to modern tractors equipped with good manifolding for the burning of heavy fuel, and where provision is made for proper control of the engine temperature so as to maintain the temperature of the cooling liquid above approximately 200 F. We do not recommend kerosene where distillate with a maximum of not over 525 F and otherwise of suitable grade for tractor operation is available. The principal reasons for not recommending kerosene are that distillate has a much better octane rating and will make for smoother operation of the engine; also, it is cheaper.

2 Where the load on the engine is less than 60 or 70 per cent of the maximum horsepower, or where the loads are irregular or vary, as, for example, in the case of operating an ensilage cutter, then we would recommend gasoline. If the job is such that rather frequent starting of the engine is necessary, then it very definitely should be operated on gasoline.

3 If the tractor is not used a large number of hours per year, and certainly if it is a small tractor, we recommend using gasoline exclusively as there will be less bother in handling the tractor on gasoline, and the saving in using distillate would not be great. There is no one answer to this problem. There is definitely a place for each type of equipment and each type of fuel. The final decision as to which will be used will rest with the particular operator in each particular case as to which kind of work predominates; also personal preference will enter in to a large extent. It seems likely that for the smaller tractors which are used more and more extensively for a wide variety of jobs, including hauling and many light jobs, there will be a greater advantage here for using gasoline, whereas for larger units which are used for heavier work the advantage would be in favor of the distillate. If the heavy-duty work predominates, it seems advisable to have a kerosene-distillate tractor that could be quickly and easily shifted to gasoline for the lighter jobs. However, if most of the jobs are variable loads or light work, then it would seem advisable to purchase a straight gasoline-burning, high-compression engine. Certainly if the engine is to be operated on gasoline most of the time, then it would be advisable to plan to operate on gasoline *all* the time and use high compression so as to secure the maximum efficiency from the fuel and maximum performance of the engine.

RECOMMENDATIONS

1 As to the recommendations for future development, I should like to suggest that a committee be set up to develop standards of low volatility fuel, this committee of course working with and through the American Petroleum Institute. Fig. 2 indicates a great need for some standardization along this line, and such discussions and reports which I have seen and heard recently indicate that work along this line has been done with gasoline and to very satisfactory ends.

It seems possible to have definite classification schedules of different fuels and have numbers or letters applying to them, a system somewhat similar to the present classification of lubricating oils. Then the manufacturer could produce an engine to operate on a certain specific grade of fuel; this could be indicated on the engine and in the instruction book. It should be possible for the user of this equipment to go out on the open market and purchase that particular grade of fuel by name or number.

2 I should like to repeat the suggestions made earlier, that a comprehensive and accurate survey be conducted to show definitely what the difference is in engine wear when operating on gasoline or distillate. It would seem that this investigation should cover only the equipment produced the last few years because of changes and modifications in design that took place in that time which tend to produce better results and minimize repair bills.

3 I would like also to suggest the possibility of an engine with variable compression, the design of one make of Diesel which has two compression ratios; one for Diesel operation and one for Otto-cycle operation for starting suggests variable compression, making it possible to quickly change the compression ratio so as to be suitable for high octane rating gasoline or low octane rating distillate. Another method would be interchangeable plugs to quickly change the compression of the engine when the shift is made from gasoline to distillate. With this type of design, assuming it could be developed to be practical at a comparatively low first cost, it would be possible then for the operator to use the particular type of fuel that would be best suited for the particular condition and secure the most economic results from each, thus in the long run giving him the lowest possible total operating cost.

The Refiner's View of the Tractor Fuel Problem

By M. D. Gjerde

IN THIS paper on the tractor fuel problem from the point of view of the refiner, it is not the intention to consider the details of manufacture of petroleum products for tractor engine fuel, but rather to treat this subject from the viewpoint of the manufacturer and distributor of such products.

Since the demands for definite types of petroleum fuel have induced their manufacture and dictated the extent of their distribution to a great degree, some past history in this connection is of interest. For many years after the discovery of crude oil, there was no demand for its lightest fractional distillates. Gasoline was a drug on the market, but with the advent of the automobile, there was an immediate demand for gasoline, and within a relatively short time it became the principal motor fuel. The excellent distribution of both kerosene and gasoline in even remote rural territories allowed adoption of the dual fuel type as well as the conventional gasoline type engines for tractor power.

Within the last ten years, there has been a great demand for several grades of petroleum fuel, heavier than gasoline, for use in domestic oil burners. The increasing demand for these fuel oils has had a marked effect on refinery operation and has required expansion of distribution facilities. At one time it was thought that availability of a light-grade fuel oil would suffice for both domestic burner and tractor usage. However, new and improved methods of evaluating the burning quality of domestic burner oils have led to the conclusion that, although the volatility requirements may be identical, those products which perform most satisfactorily in tractor engines are not entirely suitable in oil burners.

In recent years, liquified petroleum gas, butane-propane, has been adopted for fuel purposes. Its performance in internal combustion engines is more satisfactory under heavy load conditions, such as are encountered in tractor operation. However, because of the special adaptations in equipment necessary for its use, and the problems peculiar to its distribution, it is not included in this discussion of tractor fuels.

The adoption of the high-speed Diesel engine for automotive service has also created a demand for a particular type of fuel. Although Diesel-powered tractors are not yet used extensively for farm purposes, their use is increasing rapidly in other fields, and is requiring distribution of a fuel having distinctly different characteristics from those most desirable for use in carbureted engines. The characteristics required in a satisfactory high-speed Diesel engine fuel, likewise, are not or, at least, may not be fulfilled by domestic burner oils in general use.

There has been a definite effort on the part of major oil companies to cooperate with the builders of automotive equipment, providing improved fuels and lubricants, to allow and encourage advance in design by the latter. Those in the industry concerned with the manufacture and sale of tractors undoubtedly appreciate the efforts of these oil companies, who pioneered in providing thorough distribution of petroleum products in the rural territories. To provide such distribution of fuels, it has been necessary to install storage facilities at locations governed by concentration of consumption, and frequently only a few miles apart. The large investment involved is apparent when it is realized that an average tank car storage installation represents an investment of approximately $800.00.

The choice of fuel for use in a tractor is dependent primarily upon the design of its engine, but in some instances may be influenced by other factors such as operating conditions, fuel prices, general economic conditions, convenience, etc. For discussion of fuel qualities, the following general classification may be used:

1 Gasolines, and heavy (lower API gravity—less volatile) fuels for Otto-cycle engines

2 Diesel fuel oils for automotive Diesel engines.

Gasolines. Of the three grades of gasoline regularly marketed, namely, premium, regular, and third grades, which differ from each other principally in anti-knock qualities, the latter two are in most general use for tractor power. Satisfactory performance characteristics in a gasoline are indicated by its meeting the following requirements:

1 Distillation — balanced volatility, seasonally controlled, to provide easy starting and rapid warm-up, full power output, and freedom from vapor lock

2 Vapor pressure—along with correct volatility, to provide freedom from vapor lock at elevated temperatures and altitudes

3 Octane number—sufficiently high to provide freedom from detonation at the engine compression pressures encountered

4 Chemical stability—resistance to oxidation to provide freedom from gumming

5 Chemical purity—well refined and of low sulfur content to provide freedom from corrosion.

Heavy Fuels. The properties desirable in fuel, heavier than gasoline, for use in lower compression engines are of great interest because of the preponderance of farm tractor engines of the dual-fuel type. Satisfactory performance characteristics in a heavy fuel are indicated by its meeting the following requirements:

1 Gravity—low API gravity, consistent with other qualities, to provide high potential heat content per gallon

2 Distillation—balanced volatility and suitable limits in boiling point range to provide (a) uniform distribution of carbureted mixture at reasonable intake manifold temperatures, (b) complete combustion for high realization of heat content and to guard against residual deposits in combustion chamber and excessive dilution of the crankcase oil, and (c) full power output and flexibility of operation

3 Octane number—sufficiently high to provide freedom from detonation at engine compression pressures encountered

4 Refinement—well refined, of low sulfur content,

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Ill., June 22, 1937.

Author: Automotive division, technical department, Standard Oil Company (Indiana). Mem. ASAE.

and uniform in quality to provide (a) freedom from gumming, (b) freedom from corrosion, and (c) consistency in performance.

Because of its low cost per gallon, many tractor operators using heavy fuel have not given great consideration to fuel quality, except to the extent that no operating difficulties were encountered in its use. This is particularly true of octane value which is most important in providing satisfactory ignition quality.

The following kinds of heavy fuel are commonly used in low-compression engines:

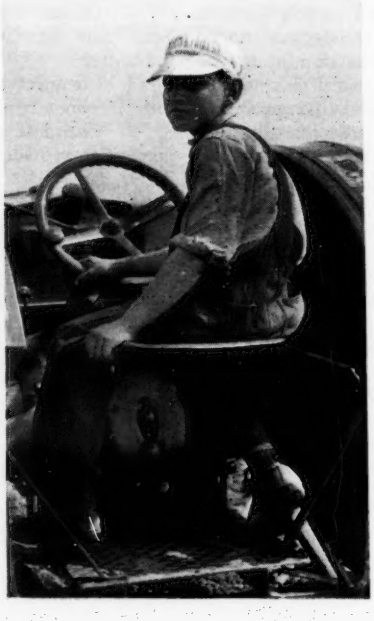
1 Kerosene. A straight-run product normally of low octane value. Although kerosene is not the most satisfactory fuel for use in internal-combustion engines, a survey of midwestern states shows that approximately 21 per cent of the kerosene sold in those states is used in tractors.

2 Distillates. A general class of heavy fuels of varying quality and usually not refined for any definite service. They may or may not possess most satisfactory ignition qualities, since high octane is generally not one of the requirements used for control in their manufacture.

3 Volatile Type Distillates. Products having gravity and volatility characteristics varying between those of gasoline and typical heavy fuel. They are frequently made by spiking distillates with gasoline and, therefore, do not necessarily have the qualities desired. These fuels, because of their lower boiling range and consequent higher API gravity, do not have as high potential heat value as other heavy fuels. Their advantage in somewhat easier starting characteristics frequently results in their use at engine temperatures too low for satisfactory performance resulting in high engine wear and excessive dilution of crankcase oil.

4 "Tractor Fuels". Fuels made specifically for use in low-compression carbureted engines. The most satisfactory of these are high octane fuels of controlled uniformity built to give optimum performance in the average tractor designed for the use of heavy fuel. The superior ignition quality of these fuels is provided by their manufacture from cracked rather than straight-run stocks. When the cracking process was invented by Dr. Wm. Burton, the aim in its use was to obtain a greater yield of gasoline from crude oil. In addition to accomplishing this increased yield, however, the process produced products having lower API gravity, therefore, greater heat content per gallon than straight-run fuels of similar volatility, as well as superior ignition quality.

Diesel Fuels. Automotive Diesel engines operate efficiently on relatively heavy petroleum fuels. These fuels are of sufficiently high flash point to offer a desirable safety quality, and because of their low API gravity provide high heat content per gallon. They should be of sufficiently low pour point to allow injection at the low operating temperatures encountered. They should not contain heavy residual portions, as evidenced by excessively high 90 per cent or maximum boiling point distillation temperatures, to guard against combustion chamber deposits. Although high sulfur content is not as objectionable in a Diesel fuel as in those for other internal-combustion engines, it is safer to avoid the use of fuels abnormally high in sulfur.



To be a satisfactory high-speed Diesel engine fuel, however, it is most important that the product possess the proper characteristics as regards:

1 Viscosity—low enough to allow correct atomization for combustion and high enough to provide necessary lubrication and satisfactory metering in the injection pump

2 Cetane number—sufficiently high for proper ignition quality to provide ease in starting, smooth running, clean combustion, and freedom from detonation

3 Cleanliness—minimum sediment and moisture content, to guard against injection pump plunger and cylinder wear by suspended solids.

Since the nature of ignition qualities desirable in Diesel fuel are the opposite of those required for best performance in carbureted engines, straight-run rather than cracked fuels are most suitable.

From the point of view of standardization in fuels for tractors, least concern need be given to gasolines. The wide usage of this fuel in passenger car and commercial equipment has naturally tended to dictate its quality and has demanded its thorough distribution. For tractor use, regular grade, commonly called "70 octane gasoline", is recommended for high-compression gasoline engine units. This product or a reliable brand of third grade gasoline is also recommended for use in tractors with conventional gasoline engines, for lower compression engines of the dual-fuel type when a light fuel is chosen, and for starting and warm-up of the latter regardless of the fuel used thereafter.

Although automotive Diesel fuel qualities have not been standardized to the same degree, no great difficulty is being encountered due largely to the fact that the manufacture of this equipment is a specialized one, and the individual builders have given consideration to quality requirements of fuels for their engines. Distribution of Diesel fuels, which fulfill the quality requirements specified by the engine builders, is being extended as rapidly as sufficient concentration of consumption develops.

In the range of petroleum fuels classed as heavy fuels, for use in the lower compression carbureted engines, however, there is lack of uniformity in the general supply. In territories where tractor fuel of the satisfactory type previously described is available, it is known to be the preferred heavy fuel. The thorough distribution of one grade of completely satisfactory tractor fuel should meet the combined requirements of the various tractor engines designed for the use of heavy fuel. The user can, of course, evaluate fuel by its performance, but assurance of a uniformly satisfactory supply depends upon the reliability of the company from whom he purchases.

The assured use of a superior type heavy fuel would enable the tractor manufacturer to improve the design of his dual-fuel engines. The permissible increases in compression pressures that would be made possible by the consistent use of this higher octane fuel would result in higher efficiency of these engines with the use of gasoline as well as with the heavy fuel. This possibility is already being developed and its success will have a favorable influence on the future of the dual-fuel tractor.

Proposed Standards for Tractor Fuels

By L. B. Sperry

IT NO DOUBT seems strange to the younger men here that kerosene was the first and practically the only useful petroleum derivative. In its earliest usage it was necessary to pass legal restraints as to its permissable gasoline content, and the blowing up of kerosene lamps because of excess volatile in the kerosene caused many a fire in homes. Refiners wasted many gallons of good gasoline because of no market for it, and the temptation was strong to market via the kerosene lamp as much gasoline as the kerosene could take.

Then came the gasoline engine as a competitor to steam for power and a little later the automobile appeared, and there has since been such a demand for gasoline that processes to procure a greater volume from the crude oil had to be developed. About 1910 there began to be an excess of kerosene and heavier derivatives (useless then) because of the demand for gasoline. This caused the search on the part of the engine designers for means of burning kerosene. The demand for kerosene had been further reduced by the introduction of electricity for lighting. Kerosene continued cheap until about the beginning of the World War because suitable means for its conversion to gasoline had not been developed. Then came the Burton process which was the earliest commercial and is still one of the most successful of the cracking processes.

The next stage in fuel development was to use for cracking stock some of the by-products less desirable than kerosene as these processes had caused kerosene prices to nearly equal the price of gasoline, and today much of the residues above the kerosene range of distillation are converted to gasoline by the cracking method of refining.

Where originally 17 per cent of crude oil could be converted to gasoline by straight-run processes, we now convert nearly 40 per cent of the crude into gasoline with resultant reduction in the amount of kerosene permitted to be sold—it has become more valuable as a source of gasoline. In the last ten years there has also been created the oil-burning domestic heater which provides a very attractive market for those fractions of the crude above the gasoline range and below the lighter lubricating oils, so that the cheap, drug-on-the-market fuels are no longer available in troublesome volumes.

Automobile and motor-truck fuel requirements because of the need for engine flexibility and responsiveness to throttle position, are still met only with *gasoline*. We shall therefore see no let-up in the demand for gasoline, and this means it will never again become a *price* fuel. Because its cost is also artificially increased very materially due to its ability to furnish revenues, via taxes, for political requirements, fuels *less expensive* are demanded to operate the tractors owned by those farmers in the uncertain crop areas, and in depression periods even those farmers in the choice land areas turn to cheap fuels. It is likely, therefore, that "distillates or tractor fuels" will be in growing demand.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Ill., June 22, 1937.

Author: Engineer, International Harvester Co.

There is a certain peculiar psychology about this situation. Tractor buyers are generally insistent on equipment that will handle heavier fuels, yet probably 70 to 80 per cent of the tractors in use operate almost entirely on gasoline, and many of them because of their manifolding heated for heavy distillate vaporization are inefficient users of gasoline. The *convenience* of gasoline operation is undoubtedly the explanation, for at the present spread of cost per gallon between a *suitable distillate* and *gasoline*, the cost *per acre of work done* is materially less using the distillate. There is also little truth in the general belief that gasoline operation provides longer life to the engine parts than is possible to secure with distillate. When proper use is made of the equipment provided for distillate, upkeep costs are comparable to upkeep costs where only gasoline has been used.

There is one feature of the situation, however, that is most unfortunate and must be corrected before a solution of the distillate-fuel problem becomes possible. This is the absolute lack of uniformity in quality and characteristics of the liquids sold as distillate. The well-known, larger oil companies are not furnishing uniform quality of these fuels, and the small vendors operating where these large companies have not made their stocks available are guilty of nearly every practice imaginable in their blending or spiking of products. And the farmer is powerless to determine the fuel quality until he has made his purchase and tried to use the fuel.

That this condition exists has been forcibly impressed upon your speaker during the last ten weeks. In that period it has been our privilege to interview several hundred of our local tractor dealers and branch house organizations on questions of tractor interest, and one very particular question has been the fuels available and generally used by owners of tractors which they have sold. This investigation has covered organizations in twenty-six of the states between the Rocky Mountains and the Atlantic Ocean. The evidence was very definite that substitute fuels were of every variety and ranged from "Bearwash" in northwestern Montana, (a crude containing nearly 6 per cent of gums, carbon, tar, etc., but possessed of a lot of very low volatiles and extremely low flash) to a distillate in Georgia so good, yet tax exempt, that the tractor operator filled his storage tanks with it and is keeping it for *starting* purposes in order that he may burn the distillate he usually obtained from this same supplier.

In east Texas distillate is not widely distributed, undoubtedly because cheap gasoline has taken its market. From our dealer information on this question we could spend much time in describing the fuels available. No uniformity and a quite radically different product is their story. The condition described is world wide. Europe is struggling to burn its supplies of Mazut, Diffusine, Treibstoff, Gazoil, etc.

In our own laboratory, and since last year when we were informed that standardized distillates and burner oils had been agreed upon by the major organizations, we have examined many fuels bought in quantities direct from the refineries and our results have afforded a "shotgun" diagram—much range in *flash*, initial, end point, octane value, etc. If this condition cannot be corrected, it is time the refiners admitted the fact. We believe they and their

chemical staffs know how to provide *uniformity* in fuels and can provide various types needed at reasonable cost. It also seems that the refining processes are such that the whole crude oil volume, variable as it is in the different fields, can be completely broken up into usable fractions, without leaving in-between by-products that have no definite market and which because of this become drug-on-the-market fuels available so cheaply as to invite the engine owner when short of funds to attempt to use them. If this cannot be done and without serious cost penalty for the standard fuels needed, there is no bright future for the standardized fuel program.

It might be asked here why the tractor owner attempts to use these bad fuels. There are three prime reasons which may explain this:

1 Their cheap cost per gallon; this disappears whenever demand uses the available supply.

2 The high taxes imposed in most states for good fuels, and of which taxes the legislator "friends" of the farmer are rapidly enacting laws preventing their return to him.

3 The unreasonable and misleading advertising of the tractor-selling fraternity stating how readily "our tractor" uses these fuels.

The farmer generally is short of money most of the year, consequently is tempted to buy as cheaply as possible, and in view of the above situation his attempts to use such by-product fuels is very natural.

Reviewing the situation as outlined, we are now ready to present our views on the possibility of effectively marketing a standard tractor fuel. The considerations are much as follows:

1 The whole supply of crude oil must be converted into standardized fractions so that no by-product or drug-on-the-market stocks are left. How can this be done? The engine designers must help by so designing that the units intended to use distillates respond uniformly to the selected standard, yet will not run at all well on any other of the standard approved fuels. The dry *gas* engine and the automotive engine will take care of the fuel supply composed of the light fractions of the crude. The Diesel engines and domestic heating oil burners, together with the forging, heat-treating, etc., manufacturing fuel requirements will consume all the heavier fractions not convertible into gasoline or lubricating oils. It seems to the writer that there may develop a situation such that it may be necessary to set aside for this tractor fuel material that is more valuable as cracking stock, and as a result tractor fuel prices will become so high—as is the case of kerosene which must still be provided for remote illumination demands—that tractors will operate again on gasoline. Until this situation does develop, it is certain that a *standardized distillate* will be a welcome relief to the tractor industry.

2 Distribution of such fuels must reach into the remote areas where the tractor finds its greatest power needs.

3 Extravagant advertising of engine ability to perform on "this-and-that" must be discontinued.

What may this standard fuel be like? Dr. Gjerde (in another paper in this issue) has roughly outlined it. Personal opinion is that the tractor engineers do not agree closely on what is needed and that to suggest closely defined specifications until there is better agreement between these men is to "lead with your chin." Nevertheless, it was a part of the agreement between your speaker and Mr. Olney, secretary of the ASAE, that such specifications would be offered. The following proposed specifications represent our opinion of what such a fuel can be, and still be made available at reasonable cost:

Tractor Fuel Specifications

1 The fuel must be free from suspended and mechanical impurities.

2 The fuel must contain no water.

3 The fuel must be as free from gum content as the better grades of gasoline; *it should be gum free.*

4 The fuel must be of controlled distillation range, and end point should not be higher than 550 F. (It would be better if end point could be 500 F.)

5 Recovery on complete distillation should be above 99 per cent.

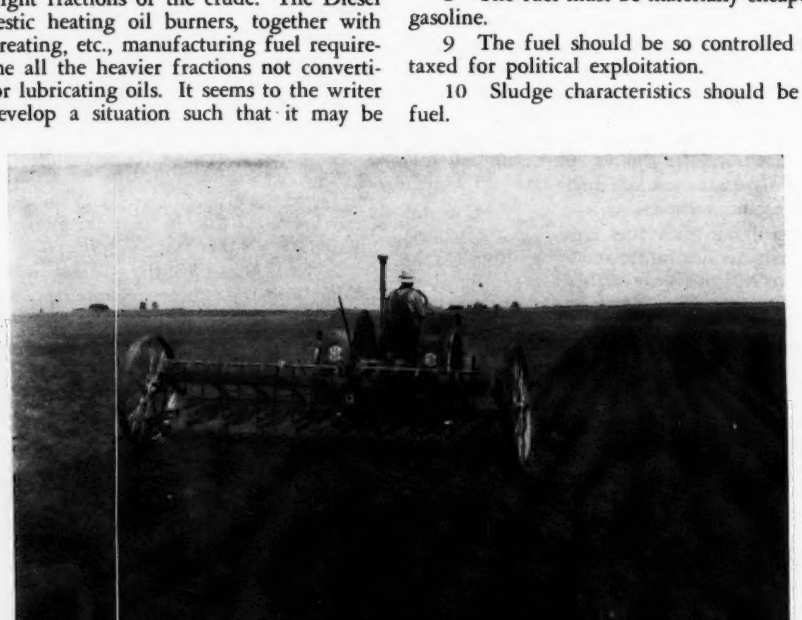
6 The fuel should carry enough light fractions to ensure perfect ignition quality at moderate manifold temperatures. It must not be so "spiked" that engines can be richly adjusted and operated while manifolds *are cold.*

7 The octane value must be so high as to prevent detonation—not lower than *40.*

8 The fuel must be materially cheaper than 70 octane gasoline.

9 The fuel should be so controlled that it cannot be taxed for political exploitation.

10 Sludge characteristics should be left out of this fuel.



Insulation Under High Humidity Conditions

By A. D. Edgar

DURING the past six years the U. S. Bureau of Agricultural Engineering has been conducting an investigation on the storage of white potatoes in northern Maine. The study of the use of insulation under high storage humidities is an outgrowth of the storage investigation. Insulation was found to be an important part of storage-house construction. We found much of it was needed, but that the northern potato warehousemen could not afford to use the required thickness of the kinds commonly employed in cold storage work.

Our first problem was to find a simple and economical means of securing desirable storage conditions for white potatoes adapted to the weather during the storage period in the northern late-crop potato area.

The storage of large quantities of bulk potatoes calls for a type of building that has definite structural requirements. To secure sufficient wall strength 2x6-in studding are required. Thus it was necessary to adapt our insulation to the structural requirement, and to secure a high insulation value per dollar invested.

One of the principal defects of storages had been their rapid deterioration. Important structural members often failed after 5 or 6 years of service. This brought up the problem of determining an economical yet relatively long-lived method of insulating.

Had our problem been to make the building last a long time, that could have been done by ventilating sufficiently to keep all parts of the structure inside the siding and below the roofing dry. We often find warehousemen who apparently think that the life of the building and keeping potatoes from freezing are the only problems of storage. However, the primary purpose of storage is to keep the stored potatoes in good condition with a minimum of shrinkage. We found that this could be done only by keeping the storage temperature at about 40 F (degrees Fahrenheit) and the relative humidity as high as was possible without getting condensation and dripping from the ceiling on the potatoes. The relative humidity that can be maintained in a storage is dependent upon the inside wall and ceiling surface temperature, the surface temperature being dependent upon the inside and outside air temperature and the insulation resistance of the wall or ceiling.

The use of electric fans under the ceiling to increase air circulation permits carrying higher humidities before moisture condenses on the ceiling, but in the following example gravity circulation is assumed. The insulation value considered in this discussion will be in terms of resistance to heat flow rather than conduction often used. The unit will be degrees Fahrenheit difference in inside and outside temperature for conduction of 1 Btu per square foot of wall or ceiling area per hour. In the storages considered the all-wood construction necessary to meet the structural requirements will have an insulation resistance of about 5 F per Btu per sq ft per hr. The addition of 1½ in of flexible insulation to the original construction would bring the overall insulation resistance to about 10, or the addition of 4 in of fill insulation to the original construction would bring the overall insulation resistance to about 20.

By basing the calculations upon still air at 40 F under the ceiling surface, and 12 F outside and a ceiling surface resistance of 0.6 F per Btu per sq ft per hr, in ceilings with overall resistances of 5, 10, and 20, the ceiling surface temperature would be expected to reach the dew point of the air below, that is, ceiling condensation would start when the air reached relative humidities of 88, 94 and 97 per cent, respectively. In storages with corresponding temperatures and ceiling insulating values the average actual relative humidities obtained were 72, 81 and 89 per cent, respectively; that is, actual humidities were usually below, sometimes equal to, but never above those calculated.

Fill type insulation has been found most practical for these potato storages because it costs less to obtain the needed amount. For instance, in our building with 2x6 studding, either 4 in of commercial fill insulation held in place by poultry netting as explained by Willis M. Rees[1], or 6 in of non-commercial insulation, like planer shavings, completely filling the space, are practical. This amount of insulation has been found right for maintaining the best average storage conditions. For the area under consideration, an increase in wall and ceiling insulation resistance from the desirable value of 20 to a value of 30 to permit higher humidities results in an opposite effect as far as the total moisture removal is concerned, in that the extra ventilation required to remove heat given off by the potatoes in the latter case results in removing an excess of moisture, and causes increased potato shrinkage.

Non-commercial fill insulation in storage walls has been in use, in the area studied, for over 50 years. The results obtained were sometimes very good and sometimes very poor. I know of a building in Presque Isle, Maine, which was used for 45 years as a potato storage. Repairs made during this period consisted principally in replacing floors and roofing. The 6-in wall space was filled with sawdust. It was then sold to a plumbing company who repaired and altered it for use as a warehouse for their supplies. In cutting through the old walls for windows they found that some of the original sawdust fill was as bright as if it had just come from a mill, while other spaces were found filled with badly weathered and dirty sawdust. Some time before the World War, M. S. Van Dusen of the U. S. Bureau of Standards in talking with S. J. Dennis, refrigeration engineer of the U. S. Bureau of Agricultural Engineering, about the use of fill type insulation in cold storage work, explained and later published his theory[2] "of placing an impervious membrane between insulation materials and the *warmer air* with the insulation ventilated to the *colder air*." *(Continued on page 361)*

Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Ill., June 23, 1937.

Author: Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. ASAE.

[1] AGRICULTURAL ENGINEERING, vol. 18, no. 4, 1937, pp. 159, 160, 163.

[2] U. S. Bureau of Standards. Circ. 376. October 17, 1929.

Lightning Protection as an Extension Project

By John R. Haswell

THE presentation of farm fire protection methods in agricultural engineering extension work should, in most states, include some practical lightning rod systems. (I use the term "rod" instead of "conductor", as that is in the farmers' language, although most of the work is now done with cable.)

The principles are sometimes demonstrated in our agricultural engineering extension work in Pennsylvania, with small models and a static machine, but recently we have been using a bell-ringing transformer and a Ford coil. A bigger coil would give a longer spark, but we have not tried to reach the ideal since most of the work is done with lantern-slide lectures. The slides consist of a number of photographs taken in Pennsylvania and drawings mostly from Underwriters' Laboratories. Many of the drawings are made direct on prepared slides. Red and orange cellophane between the glass makes a good fire glow and saves coloring. Two of our best pictures are shown by Figs. 1 and 2. We use slides without lettering to hold attention, but large charts of the same illustrations are labeled as in the titles of the figures. Some county agricultural agents use the charts at county fairs and community shows to back up the winter meetings work on their program. Several farmers have remarked that the poor installation (Fig. 1) looked as if we had copied what was on their barn. About the only bad feature often seen and not shown is that of having the conductor go up over a frame ventilator, and not around it on a level, as shown in Fig. 2.

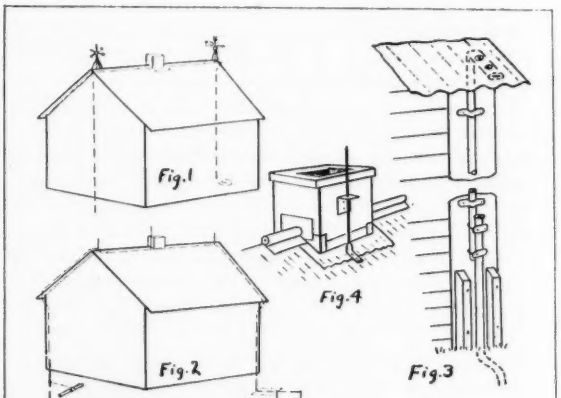
The recommendations of the U. S. Weather Bureau, as given in Farmers' Bulletin 1512; the Code for Protection Against Lightning, Handbook No. 17, U. S. Bureau of Standards, and the Underwriters' Laboratories publications form much of our source material. However, to reach the small farmer who wants specific information on how to ground a metal roof, we recently issued a one-page mimeograph bulletin, entitled "Grounding Metal Roofs for Lightning Protection," which is available in all county agents' offices as well as from the college mailing room. The following information is from this bulletin, much of which applies to all types of systems:

"If not grounded, metal roofs do not protect from lightning and may even increase the risk," says U. S. Farmers' Bulletin 1751, "Roof Coverings for Farm Buildings." (See also Farmers' Bulletin 1512, "Protection from Lightning.")

Small buildings, not over 80 ft long, need only two diagonally opposite corners grounded. Large ones—all four corners, possibly some grounds between, none over 110 ft apart. On T or L-shaped buildings an additional ground should be placed at the outside corner.

The down conductors (Fig. 3), if of pipe, should be flattened at the upper ends for 6 in so that at least 3 sq in are in contact with the metal roof. They should be bolted to the roof with the heads of the bolts on top of the roof with washers under the heads, and lock washers between the flattened pipe and the nuts. At least ¼-in diameter bolts should be used, spaced 1½ in or more apart. It is best to drill the holes before bending the pipe to fit the eave overhang. On the end of the building the rod could turn up instead of down. If the roofing boards under the metal are in the way of the down rod, it is suggested that a slot at least 5 in wide be cut so that no wood can be within 2 in of the joint. This will take care of any heating in case the joint loosens. The only heating to be expected in a good system is on the small tip of the points where the discharge enters the metal. Some conductors are built in between the shingles and the "roofers", or roof sheeting boards, on regular systems.

If the ground rod or pipe can be driven into good deep soil at the corners of the building, a depth of 8 ft may be sufficient, though highest standards call for 10 ft. If there is sand or gravel present, more contact than just one rod should be made. (See U. S. Farmers' Bulletin 1512.) Sand and gravel beds act as insulators. There is nothing to be gained by drilling into rock and in such cases the ground connection should be spread in a trench diagonally out from the building as illustrated in the bulletin. If there is a water system in the building it is best to connect to it underground, outside the building, with substantial clamps. The down conductor and ground rod should be firmly fastened together. If both are pipe, they can be flattened slightly to give better contact and held together with at least two galvanized, wire-cable clamps or clips as illustrated. Wooden guards should be used to



LIGHTNING PROTECTION DETAILS

Fig. 1. A typical old-style lightning rod installation: shallow ground; not at corner; cable coiled in top soil; ornaments cause upsets; glass balls are useless; no point on chimney; should not dip or raise around projections. Fig. 2. A standard lightning-rod installation: deep ground in good earth; connected to water pipe; ground in gravel with plate and driven rods (diagonally from building); points on all places likely to be hit. Fig. 3. A down conductor and driven ground for metal roof. Galvanized pipe (½ or ¾ in) or approved lightning conductor. Galvanized iron pipe clamps or copper clips fastened on wall as shown. Leaded screws for masonry. Clips of same metal as conductor. Fig. 4. This shows the point or air terminal on the chimney when a metal roof is grounded

Author: Professor of agricultural engineering extension, The Pennsylvania State College. Mem. ASAE.

prevent accidental injury where the down rods are close to the ground. A large metal pipe should never be placed around the rod, as a guard, without electrically bonding it at its upper end to prevent forming an arc which may cause the metal to melt. Where it is necessary to drive past the corner of a building, it is better to put the rod on the side where there is the smaller chance of damaging it. It should be 2 ft out from the foundation.

Many lightning rod systems were formerly placed straight down the ends of the building from the ridge to earth, and disregarded the corners, on the false idea that the lightning would always hit the points and go down the rod in the shortest possible course (Fig. 1). This often gave no trouble with wood shingles or other nonmetallic roof covering, particularly if there was no cellar under the building. The corner locations for the down rods not only protect the eaves and corner posts but also the foundation walls from being cracked by a discharge. However, when the roofing has been replaced by metal, not grounded at the eaves, loss has resulted by flashing at the corners, firing the hay mow and the stock bedding, even with rods on the ridge and down the middle of the end of the barn.

Regular lightning-rod cable may be used for the down conductors and connection made to the roof through a clamp around the cable with two holes in it for the roof connection. Metal siding should be bonded at the eaves to the roof and the corners grounded.

Chimneys or other projections (Fig. 4) should have points on them unless provided with a metal roof connected to the main covering. The points may be a $\frac{5}{8}$-in round rod or $\frac{1}{2}$-in galvanized pipe securely supported by an L plate at least 2 in wide by $\frac{1}{4}$ in thick, projecting out far enough to make the point plumb. The plate may be fastened to the brick by expansion screws or have a band around the chimney. Regular points may be used but they must be within 2 ft of the chimney and project 10 in above it. They are bolted or riveted to the roof similar to the down rods.

As one lightning discharge may consist of a number of flashes, as many as forty having been observed, several places may be hit. Therefore, if part of the building is not covered by a metal roof, it should have a complete system of conductors, interconnected to the metal roof. A metal hay track should be attached at each end through the hangers.

It is advisable to paint all connections to prevent rust or corrosion, and the system can be painted to match the building. The better systems often show the least. However, the sheets, flashing, connections, etc., should not be painted before applying as the electric bond will be broken.

It must be remembered that a lightning rod system is no better than its grounds and damage to them can be prevented by using wooden guards.

The foregoing information supplied in our mimeograph bulletin is not intended to supplant the work of a recognized, reliable installer of master label equipment, but it is believed it tends to create, in the mind of the farmer, an appreciation of good protection from lightning.

Insulation Under High Humidity Conditions

(Continued from page 359)

It seems probable in the instance of the old storage cited, that where by chance the more impervious wall was between the insulation and *warm air,* the sawdust stayed in good condition; and where the more impervious wall was, between insulation and *cold air,* the sawdust stayed wet most of the time.

From our experimental results with storages, under working conditions, we found that rock wool fill insulation sandwiched between two layers of reinforced waterproof paper had absorbed moisture equal to 10 per cent of its dry weight at the end of the storage season. When the same walls were provided with a $\frac{5}{8}$-in auger hole in the plate for a breather, to the *cold air,* at the top of each wall section 16 in wide by 24 in high, the insulation had absorbed moisture equal to only 3.5 per cent of its dry weight at the end of the storage season. Our results tend to prove Mr. Van Dusen's theory and of course fully agree with Mr. Rees[1]. However, our problem deals with a warm interior rather than a warm exterior discussed by Van Dusen and Rees. Unfortunately as was pointed out at a meeting of the ASAE North Atlantic Section, at Skytop, Pennsylvania, in October 1936, this method of insulating does not suit those areas where the warm side of the wall is part of the time on the inside and part on the outside. In our study we found the insulation slightly drier at the end of the storage period in April than at the beginning of the next storage period in October, because during the summer months the outside air was often at a higher absolute humidity and warmer than the air in the insulation.

The use of insulation is generally justified upon the basis of savings in heating or refrigerating. Our study shows that increasing the wall and ceiling insulation resistance from 5 to 20, results in a fuel saving of 0.8 cents per square foot per season. But we also found that due to higher storage humidity, maintained in the better insulated houses, and reduced potato shrinkage, the additional value of marketable potatoes at the end of the season amounted to about 2.6 cents per square foot of wall and ceiling area for the season. The savings of potatoes are thus practically three times the savings in fuel, and together amount to about 3 cents per year per square foot of wall and ceiling area, where the storage remains filled for a full 210-day storage period. For average storages where potatoes are shipped intermittently between the second and seventh months a probable annual return of 1.5 to 2 cents per square foot of wall or ceiling area will result from increasing their insulation resistance from 5 to 20.

By careful application an insulating resistance of 20 can be secured by the use of commercial fill insulation at about the same cost as a resistance of 10 could be secured with board or blanket type insulation.

Fill type insulation is suitable for storage only when there is a one-way temperature difference, that is, where it is practically always either warmer or colder on the same side of the wall. For instance, it would not seem to fit the New England apple storage problem where it is desirable to refrigerate in the fall and heat in the winter.

Summing up the principal points to consider in insulating northern potato storages:

1 The temperature and humidity control necessary for reduced potato losses are best secured in a well-designed and adequately insulated storage.

2 Correctly installed fill type insulation meets the structural, economic, and insulation requirements.

Low Cost Two-Unit Wall Construction

By H. R. Straight

THE first cost is generally considered the only cost of a farm building, but the recent depression forced closer cost accounting on the part of the farmer. The result has been to bring into the cost consideration, in building a farm home, repairs, fire resistance, convenience and comfort, with the ability of serving as the heart of the whole farm plant.

One type of construction with low cost advantages is structural clay face tile for the exterior wall construction, with backing of suitable structural clay units on which the plaster coating is applied direct. A metal bond ties the interior and exterior walls so as to make them act together and dependably carry their load, resist side pressure as in tornadoes, and resist moisture without wetting through.

Loss of farm homes burned annually, due to lack of adequate fire protection, amounts to staggering sums. The use of basicly fireproof materials throughout is a logical method of construction under such conditions. We are going to use as a typical example of what has been recently accomplished along the line of solving the problem, the experience of A. D. W. Johnson, a dairyman, near Anoka, Minnesota. At 5:30 a. m. February 14, 1936, with the temperature at –37 F, and part of the family still sleeping, a fire spread so rapidly through his frame house that there was no time to remove even the furniture from the downstairs rooms. Overcoming this hazard was naturally uppermost in Mr. Johnson's mind, but necessity required that costs be cut low if a fireproof home was to be built within his limited means.

The new Johnson home contains no wood except the doors and windows and their frames. It measures 31x36 ft in plan. The wall construction used was a 4-in face tile wall with a 4-in interior tile wall, with a 2-in space between the walls loose filled with zonolite, which is an enfoilated or puffed mica mineral aggregate. The two walls are bonded together with ¼-in copper-steel wires, bent Z-shaped to give the proper anchorage. A metal tie for every 4 sq ft of wall surface is used. The roof construction consists of precast tile beams with a span or filler tile laid between pairs of beams, over which 3 in of a mixture of 10 parts zonolite to one part of cement is laid for proper insulation of the roof slab. Over this is placed a 1½-in thickness of sand concrete as a top coating, with a built-up asphalt roof asphalted to the cement top coating. The floors are of the same type of precast tile beams with filler tile and top coat of cement, with asphalt tile finish. The completed cost of the entire house was $5,967, or 20.3 cents per cu ft of enclosed space.

Some state codes require the wall bond to be of masonry. When such is the case the construction previously described may not be usable, but the metal bonded wall type is preferable, in my opinion. One reason is that the insulating blanket between the walls is less interrupted than with a masonry bond. Another reason is that the differential expansion between the interior and the exterior walls does not throw heavy strains into the walls, when bonded with the slight flexibility introduced with the metal ties.

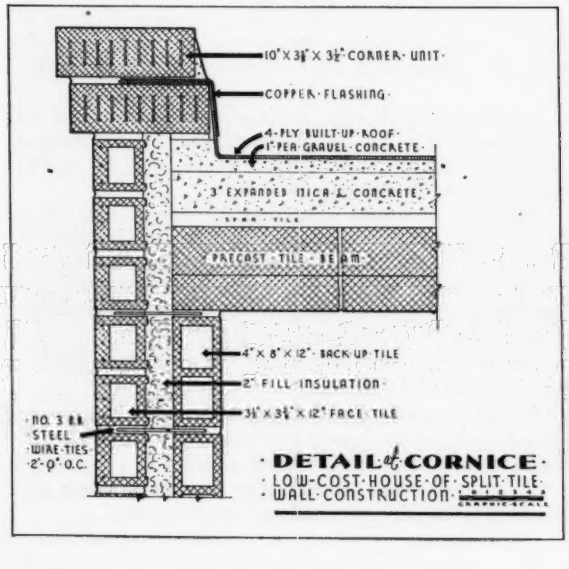
Heating costs are high in farm homes of conventional construction during the winter, if they are comfortably heated. The added first cost of a well-insulated wall is easily repaid in fuel savings in a few months of winter heating. The total cost of fuel for heating Mr. Johnson's new home for the winter of 1936-37 was less than $50.00.

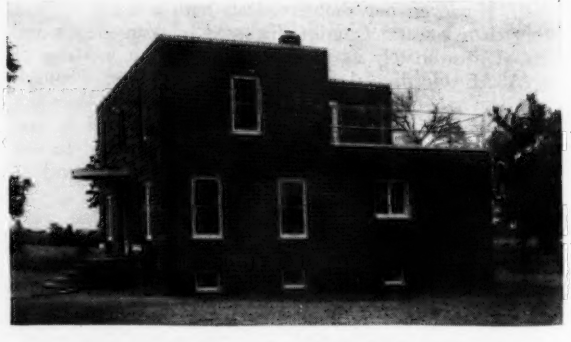
The freedom from painting and other repairs over a long period of years, experienced by those using vitrified face tile, is worthy of careful consideration. Good vitrified clay is capable of cutting glass almost like a diamond and is not subject to deterioration from the weather. The mortar joints and frame portions are partly protected from the weather by the clay units.

No attempt will be made to place a value on the added comfort, the greater convenience, and the dignified manner in which such a structure will pay its way as the capital building of the farm, but there are such cost-reducing features of which account should be taken in an accurate cost comparison.

Presented before the Farm Structures Division of the American Society of Agricultural Engineers, at Urbana, Illinois, June 24, 1937.

Author: President, Adel Clay Products Company. Mem. ASAE.


10" X 3⅝" X 3½" CORNER UNIT
COPPER FLASHING
4-PLY BUILT-UP ROOF
1" PEA GRAVEL CONCRETE
3" EXPANDED MICA L. CONCRETE
PRECAST TILE BEAM
4" X 8" X 12" BACK-UP TILE
2" FILL INSULATION
3⅝" X 3⅝" X 12" FACE TILE
NO. 3 B.B. STEEL WIRE TIES 2'-0" O.C.
DETAIL of CORNICE
LOW-COST HOUSE OF SPLIT TILE WALL CONSTRUCTION



A COMPLETE FARM HOME EMBODYING LOW COST TWO-UNIT WALL CONSTRUCTION

A Flax Seed Plot Thresher

By Roy Bainer and J. S. Winters

THE division of agricultural engineering, University of California, designed and supervised the construction of a flax thresher for threshing seed plots for the agronomy section of the California Agricultural Experiment Station. Previous observations had indicated that the peg tooth cylinder could not be used successfully for threshing the Punjab (an Indian variety) flax grown extensively in California. The two chief reasons being, first, a large percentage of the flax seed is broken during the threshing operation, and, second, the straw is of a very fibrous nature which prevents its reduction and also causes it to wind on the cylinder, beater and other internal revolving shafts.

The thresher consists of a feed table, two rubber-covered steel rolls, and a cleaning shoe of somewhat standard construction. The machine is fed by hand, and the tailings from the shoe are returned by hand to the rolls for threshing. A 2-hp air-cooled, Air-Way engine furnishes power for operating the machine. Power is transmitted from the engine to the machine by means of a 3-in leather belt. An idler on the belt may be shifted to make the belt either tight or loose, giving the same effect as having a clutch between the engine and thresher.

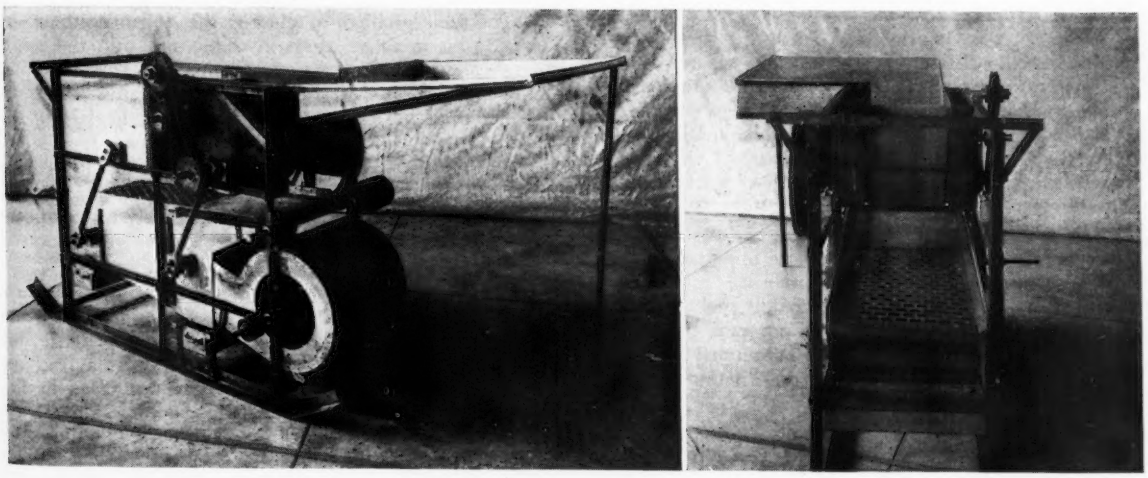
The threshing rolls consist of steel drums 8 in in diameter and 12 in long, with a ¼-in layer of very hard rubber vulcanized to them. The lower roll is supported in plain bearings which are bolted to the main frame. The upper roll is mounted in bearings which are in turn mounted in guides. This permits the upper roll to raise when wads of flax straw pass through. The center of the top roll is 3 in back of the center of the bottom roll, to facilitate feeding of the flax into the rolls. Each bearing on the shaft of the upper roll is loaded with a compression spring, having a constant of approximately 75 lb per in of deflection. The pressure on the roll may be varied by adjusting the pressure on the springs. Due to the nature of loading the roll, the pressure increases as the rolls are forced apart, by material passing between them.

Stops in the guides prevent the top roll from coming in contact with the lower roll. The clearance maintained is just sufficient to allow the rolls to clear each other, and at the same time not great enough to allow a flax boll to pass through without being broken. Clearance between the rolls is quite necessary because the two rolls are driven at different speeds. The top roll is driven at 105 rpm, while the speed on the lower roll is 95 rpm. The differential in speed, when coupled with the pressure on the roll, produces a rubbing as well as a crushing action. This combined action breaks the flax bolls and rubs out the seed. While this action is not severe enough to thresh every boll the first time through, practically every boll is broken free from the straw and at least partially threshed. The unthreshed bolls ride over the chaffer sieve and into the return, where they are collected and returned to the rolls.

The cleaning shoe is supported on four 20-in wooden (maple) springs. The springs are mounted at an angle of 60 deg with the frame. The oscillating motion on the shoe is obtained by means of a cam and roller drive. A shaft, just ahead of the shoe, has two cams keyed to it while the rollers are attached to the front of the shoe. Springs, between the shoe and the frame, hold the rollers against the cams to insure that they follow the cams. Tension springs were first installed to accomplish this, but due to too much spring breakage they were replaced with compression springs.

The action on the shoe, due to the angle of the supporting members, tends to buck the straw along. It moves ½ in vertically and ¾ in horizontally during each stroke and makes 670 strokes per minute.

Authors: Respectively, associate professor of agricultural engineering, and associate agricultural engineer in the agricultural experiment station. Assoc. Mem. ASAE, and associate in agricultural engineering, University of California.



EXPERIMENTAL FLAX THRESHER

(Left) The experimental flax thresher before the sides were put in place. This view shows the shoe mounting and drive, the method used for reversing the direction of the top roll, the fan mounting, and the feed table. (Right) A rear view of the flax thresher showing the cleaning shoe and rubber-covered steel rolls

The chaffer, or top sieve of the shoe, is of the lip type with openings of 3/4 by 1 3/8 in. The best cleaning results are obtained with a 1/8-in round-hole sieve placed about midway in the shoe. A sand screen having round holes, 1/16 in in diameter, is used in the bottom of the shoe for removing very small particles of foreign material. The middle sieve and sand screen are held in place by barrel bolts, to facilitate their rapid removal for cleaning. The tailings are caught in a drawer at the rear end of the shoe and the clean grain is caught in a similar receptacle at the front.

An air blast from a 5-blade, 16-in undershot fan operating at 270 rpm is directed, by means of a vane, up through the sieves for separating the chaff from the seed. A V-belt drive, with cone pulleys on the cam shaft and fan shaft is used to facilitate quick changes in fan speed. The fan is shuttered for the final control over the air blast.

The machine has proven quite adequate for handling the experimental flax seed plots, and as a rule it is necessary to return the tailings through the rolls only once to complete the threshing.

Graduate Research

By E. G. McKibben

A MAXIMUM contribution toward the fulfillment of a well-planned and carefully coordinated program of research is, from the standpoint of the experiment station, the most important objective of graduate research. Zeal to attain this objective should not be allowed, however, to obscure the fact that graduate research has many other objectives, some of which conflict with this primary experiment station goal.

From the standpoint of the graduate student himself, the chief objective should be to obtain as much experience as practicable in taking the initiative in research, even if it is necessary to retard to some extent the fulfillment of the experiment station program. Failure to give the student at least some experience in taking the initiative cheats him and is inexcusable.

Moreover, from the standpoint of the agricultural engineering members of the graduate faculty, research must culminate in a satisfactory thesis. This is admittedly a somewhat academic objective. It is, under most conditions, however, none the less real and imperative.

The actual process of graduate research may be divided into seven steps[1]: (1) selection of a problem, (2) survey of literature, (3) formulation of plans for the investigation, (4) carrying out these plans, (5) analyzing the results, (6) interpreting the analysis, and (7) publication of findings. It is admitted, of course, that these steps are not necessarily distinct and completely separated in all cases. It may become desirable or even necessary, for example, to change the plans for the investigation after the work has actually been started. And while analysis and interpretation cannot be completed until all experimental work has been finished, they should often be started as soon as preliminary results are obtained.

The selection of a problem, necessarily one of the first steps and certainly one of the most important, should, because of limited time, be accomplished as quickly as possible. In general, if the solution of the problem selected is to forward the experiment station program, the selection must be made with this objective in mind. This means that the agricultural engineering section of the experiment station must have a well-planned program of research with a sufficiently wide range of suitable problems. It is highly important that the student be able to make a selection which will enlist his deepest interest and challenge his best effort. Furthermore, the instructor in charge must be familiar with the experiment station program.

Every available resource of the institution and every known technique should be used to train and guide the graduate student in making an effective search of the literature.

The formulation of plans for actual research probably offers the severest test of graduate instruction. Satisfactory plans taking into account the limitations of time, available equipment and funds, experiment station plans, and thesis requirements must be completed as quickly as practicable. On the other hand, it is most important for the graduate student to take the initiative at this stage. The duty of the instructor is to furnish a maximum of inspiring and curiosity-arousing guidance and a minimum of detailed and initiative-killing directions.

It is unfortunate that in many instances the completed plans are not properly reviewed at this point. Suggestions are often made at the final examination which are of little value at that date, but which would have greatly aided the research had they been offered earlier.

The same problem of guiding the student without destroying his initiative arises in connection with the actual investigations and in connection with analysis and interpretation. However, fear of destroying initiative and self-reliance must not be used as an excuse for neglecting the student.

Finally, the student and particularly the instructor have a special obligation to obtain publication as soon as practicable. In addition it is the instructor's duty to coordinate the findings of graduate research with those of the experiment station.

It requires teaching skill to guide a student through such a program in the time available. The problem is made more difficult by the limited background of experience and training of the usual graduate student. It is a teaching task which requires imagination, judgment, and an inspiring personality as well as subject matter knowledge. Such a task should not be assigned unless the proper adjustment is made in the teaching load.

It must, of course, be kept in mind that each graduate student and his research problem is unique; otherwise he cannot be called properly a *graduate* student and his activities cannot be accurately designated as *research*.

Presented before the College Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 21, 1937.

Author: Associate professor of agricultural engineering, Iowa State College. Mem. ASAE.

[1]It is conceded that graduate research might well be divided into some other number of steps.

What Agricultural Engineers Are Doing

FROM THE USDA BUREAU OF AGRICULTURAL ENGINEERING

WITH a view to determining the possibilities of building reservoirs, sinking wells, or pumping from rivers for supplemental irrigation in Perkins, Corson, and Dewey counties, South Dakota, Carl Rohwer of the division of irrigation recently consulted with Resettlement Administration representatives, county agents, prospective irrigators, and others in those counties. This work is a part of the project, Supplementary Irrigation in the Northern Great Plains, which is being carried on in cooperation with the Rural Rehabilitation Division of the Resettlement Administration.

In Jones, Lyman, and Mallett counties, South Dakota, Dean C. Muckel, of the division of irrigation made estimates of the cost of providing irrigation water supplies for individual farms on the White River. Pumping directly from the river was found to be feasible in most cases, although on a few of the areas shallow wells were recommended. The tracts in this region which it is proposed to irrigate range from 20 to 90 acres and the estimated cost of developing a water supply varied from $7.50 to $20.00 an acre.

* * *

At the regional meeting of the American Association for the Advancement of Science, and associated societies, held at Denver, Colo., in June, J. C. Marr of the division of irrigation presented papers on "Present Status of Snow Surveying and Irrigation Water Supply Forecasting in the West," "Melting versus Weight Method for Determining Snow Density," and "Tentative Design of Electric Weighing Scale for Snow Sampler." R. L. Parshall, of the same division, presented a paper on "Irrigation Water Resources of Colorado" before the AAAS meeting, and a paper, entitled "Laboratory Measurement of Evapo-Transpiration Losses," before the joint meeting of the Society of American Foresters and the American Geophysical Union.

* * *

In an attempt to moderate air temperature by irrigation and reduce the "June drop" of small oranges, Colin A. Taylor of the division of irrigation has started a test on a navel orange orchard at North Pomona, Calif. Ten rows of trees were given enough extra irrigations to keep the soil surface moist throughout June. Thermometer shelters were set up and comparisions made between temperatures of the "moist" rows and the untreated area which has a loose dry soil mulch. Sudan grass was sown in the orchard and the fair stand obtained had reached a height of four inches by June 30. The orange bloom was late this year and chances were the fruit would not reach a size beyond the "June drop" stage until late in July. The probability of some high temperatures offers an excellent chance to make a thorough test of the possibilities of this method.

* * *

During June the Central District CCC Drainage Camps completed a total of 3,398,815 sq yd of ditch cleaning, using 24,432 man-days; 1,869,130 cu yd of excavation and embankment, using 23,309 man-days; 41,501 lineal ft of tile reconditioning, using 5,376 man-days; and 12,532 man-days were used on structures, surveys, and miscellaneous work. Local cooperation for the month in this drainage work was valued at approximately $108,000. As part of the general reduction in CCC camps, one drainage camp at Sidney, Ohio, and one at Rockport, Mo., are being abandoned.

* * *

Claude Culpin, agricultural engineer of the College of Agriculture, Cambridge University (England), spent a few days at the Bureau offices in Washington discussing various phases of agricultural engineering as they might apply to conditions in England. He left July 4 by automobile for a trip of several weeks throughout the United States, during which he plans to visit a number of the agricultural engineering experiment stations.

* * *

Alterations of a two-row celery transplanter have been completed by L. G. Schoenleber and D. B. Eldredge of the division of mechanical equipment. Fertilizer hoppers and shovels were mounted independently of each other so that two treatments, involving different fertilizer rates and placements, may be applied simultaneously. The planter was taken to Wolcott, N. Y., where two placement experiments with celery were started. Alterations are also being made to the manually fed transplanter for use with cauliflower on Long Island. The kale and spinach drills intended for the work at Norfolk, Va., during August and September are being put in shape for use.

* * *

On June 14 and 15, C. K. Shedd went to North Platte, McCook, and other points in Nebraska in company with E. E. Brackett and Aldert Molenaar of the department of agricultural engineering, University of Nebraska, to study the use of basin listers and other cultural practices in growing corn on Nebraska farms. Basin listers, which form small dams in lister furrows, are in use there this year for the first time. These machines were found on farms near McCook and as far east as Central Nebraska. On slopes up to about 3 per cent basins were successful in controlling runoff resulting from rains of 2 to 3 in falling within one hour. On slopes of more than 3 per cent the University extension service recommends contouring the rows. Contour listing without basin forming was observed on a number of fields and had evidently retarded runoff to some extent but had not been entirely effective.

* * *

J. R. McCalmont installed equipment for measuring pressures in a silo containing hay and molasses silage at the Beemersville, N. J., Branch Experiment Station. The observations of pressure are made by members of the experiment station staff. At last report, with 30 ft of silage in the silo, the outward pressure on the lower door was approximately 700 lb per sq ft.

* * *

W. H. McWilliams is on temporary appointment to work under W. V. Hukill's direction on an instrument for measuring the physical comfort conditions of the air in farmhouses.

* * *

The experimental grain storage bins at Fargo, North Dakota, have been completed by F. C. Kelly. He is developing an experimental drier which will be tried out during the coming harvest.

* * *

R. L. Parshall has reported a formula for preventing snow cores from sticking in the sampling tubes used in snow cover measurements. The formula was developed by Ranger Fortenberry of the Rio Grande National Forest, and has been used satisfactorily by him and other rangers. The directions follow: Prepare a mixture of 75 per cent cocoa butter; 20 per cent beeswax (or paraffin); and 5 per cent gasoline. Melt the cocoa butter and beeswax (or paraffin), remove from heat and allow to cool partially. Then add gasoline (being careful that there is no flame near the gasoline fumes), and mix well. Swab the sampling tube with this mixture, both inside and out, and allow it to stand for at least an hour before using. When ready to use the tube, swab it both inside and outside with a light lubricating oil. An occasional swabbing with the oil may be necessary during the sampling operation. Best samples are obtained by plunging the tube quickly.

* * *

An experimental drill for applying fertilizer to pastures and hay crops is being constructed under the supervision of G. A. Cumings. There has been a great increase of interest in the fertilization of pastures and experiments will be started this season to determine how the fertilizer should be applied. The experimental machine will place the fertilizer in drills at different distances apart and at different depths in the soil. L. G. Schoenleber and W. H. Redit are engaged on fertilizer placement experiments with cotton and tobacco in the southern states.

Contributions Invited

All public-service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new development in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

"Georgia Ag Engineer" Appears

The 1937 *Georgia Ag Engineer* recently came from the press. Containing twenty-three articles and numerous illustrations, the annual is larger and more interesting than in previous years. Although primarily from the pens of the students, several articles written by faculty members and engineers in industry were included.

NEWS

Award Committee Considering Candidates

THE rules governing the award of the Cyrus Hall McCormick Medal by the American Society of Agricultural Engineers, "for exceptional and meritorious engineering achievement in agriculture," provide that members of the Society shall have the opportunity of nominating persons whom they believe eligible for consideration by the Jury of Awards as candidates for this medal.

Between August 1 and October 1 the Jury of Awards will be considering candidates for the medal to be awarded in 1938, and ASAE members, who desire to do so, should promptly submit the names of their candidates for the award to the Jury. Each nomination must be accompanied by (1) a clear and comprehensive statement of the reasons for proposing the candidate and (2) a record of the candidate's scientific or professional achievements in sufficient detail to enable the Jury to properly pass on his worthiness to receive the award.

Nominations must be in the hands of the chairman of the Jury of Awards not later than October 1, and all such nominations should be addressed direct to the chairman, Mr. R. W. Trullinger, Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C.

National Resources Committee Report

AGRICULTURAL engineering implications are definitely included in the report, entitled "Technological Trends and National Policy, Including the Social Implications of New Inventions," prepared by the sub-committee on technology of the Science Committee of the National Resources Committee, and recently submitted to the President.

The printed volume of nearly 400 pages, measuring 9x11½ inches, covers the subject in three parts: "Social Aspects of Technology," "Science and Technology," and "Technology in Various Fields." Under "Social Aspects of Technology" are sections on national policy and technology, the prediction of inventions, social effects of inventions, resistances to the adoption of technological innovations, and unemployment and increasing productivity.

Sections under "Science and Technology" are the relation of science to technological trends and the interdependence of science and technology.

"Technology in Various Fields" covers agriculture, the mineral industries, transportation, communication, power, the chemical industries, the electrical goods industries, metallurgy, and the construction industries.

Mr. S. H. McCrory, chief of the U. S. Bureau of Agricultural Engineering, was chairman of the committee responsible for the section on agriculture, which includes 48 pages. It is clearly stated that technological changes affecting agriculture are not limited to the fields covered in this section of the report. These fields, which were selected and developed as important examples, include mechanization and engineering, plant breeding and improvement, trends in animal technology, insect pests and their control, weather and forecasts, soil use and conservation, chemical fertilizers, marketing products, industrial utilization of farm products, trends in forestry, technology and wildlife, the dairy industry, and cotton pickers.

The complete report is available from the Superintendent of Documents, Washington, D. C., at $1.00 per copy.

Plow Exhibit Pictures Available

PICTURES were taken of the historical plow exhibit, a feature of the annual meeting of the American Society of Agricultural Engineers at the University of Illinois in June. Black and white prints can be furnished on order at 15 cents each, or $2.75 per set of 19 prints. The print size is 5x7 in. Orders should be addressed direct to R. R. Parks, Agricultural Engineering Department, University of Illinois, Urbana.

Pacific Coast Section Announces Fall Meeting

OCTOBER 16 is the date set by the Pacific Coast Section of the American Society of Agricultural Engineers for its fall meeting, to be held this year at Asilomar resort, Pacific Grove, California, the same location as selected for the 1938 annual meeting of the Society.

Subjects tentatively listed for discussion include farm equipment especially adapted for Salinas Valley, orchard heating, sterilization lamps, poultry housing in California, principles of air conditioning, basin listers, refrigerator truck transportation, apple storage, fluctuating water table in Salinas Valley, sulphur houses, and dehydration of farm products.

Mimeographed Papers and Reports Available

THE following papers and committee reports of the ASAE annual meeting at Urbana, Illinois, in June are available in limited quantities for free distribution (one copy each) to ASAE members:

COLLEGE DIVISION

- Extension Methods, by J. P. Fairbank
- Summer Field Practice Course in Agricultural Engineering, by B. D. Moses
- The Relationship of Extension Engineers to Workers in Other Technical Fields, by C. W. Warburton
- Agricultural Engineering in the Vocational Program, by F. W. Peikert
- Agricultural Engineering in the Nonprofessional Curriculum, by Harold E. Pinches
- Proceedings of the Committee on Relations with Vocational Education (for year ending June 20, 1937)
- Rural Electrification and Soil and Water Conservation (A contribution of the committee on Relations with Vocational Education, 1936-37)
- National Farm Mechanics Contest (A contribution of the Committee on Relations with Vocational Education, 1936-37)

FARM STRUCTURES DIVISION

- Why Have Better Farm Buildings, by Wm. Boss (published in AGRICULTURAL ENGINEERING for July 1937)
- Utilizing the Structural Value of Insulation in Poultry House Construction, by H. M. Ward
- Results of Recent Investigations on the Spontaneous Heating and Ignition of Hay, by H. E. Roethe

POWER AND MACHINERY DIVISION

- Engineering Problems Involved in Methods of Pest Control (A contribution of the Committee on Insect Pest and Plant Disease Control)
- Report of the Weed Control Committee
- Report of the Committee on Garden Tractors
- Report of the Joint Committee on Machinery Design for Terraced Land Operation

RURAL ELECTRIC DIVISION

- Irrigation as Crop Insurance, by C. C. Bell
- Factors in Rural Electric Service, by I. L. Craig
- Pennsylvania's Plan for Rural Load Building, by C. L. East
- Responsibilities for Adequate Farm Wiring, by G. W. Kable
- Use of Electricity in Fruit Farm Operation, by W. C. Reed
- Helping Farmers Prepare for Electric Service, by H. N. Stapleton
- Report of the Committee on Uses of Electric Light in Agriculture
- Report of the Committee on Power Applications in Agriculture

SOIL AND WATER CONSERVATION DIVISION

- Mechanical Methods of Water Conservation on Pasture and Range Land, by P. C. McGrew
- An Extension Program in Soil and Water Conservation, by W. H. McPheters
- Terracing Extension Methods in Alabama, by J. B. Wilson
- Committee on Soil Erosion, reports of subcommittees on
  - Terrace Equipment and Construction
  - Terrace Project Planning
  - Control of Erosion in Terrace Outlets
  - Control of Gully Erosion
  - Reservoirs and Ponds
  - Contour Furrowing
  - Cost Data

ASAE Meetings Calendar

October 16—Fall meeting, Pacific Coast Section, Asilomar Resort, Pacific Grove, California.

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

"SECURITY of Employment in the Engineering Profession" is the title of the fourth of a series of summary articles covering the results of the survey made by the U. S. Bureau of Labor Statistics at the request of the American Engineering Council. Although this article is based on the data supplied by only 35,559 of the engineers who responded to the survey questionnaire, it seems to be a fair sampling of experience and presents some interesting information regarding the medium through which engineers find positions, the extent of the use of employment contracts and engineers patent privileges.

Four-fifths of all engineers reporting in the survey claimed to have found their jobs through personal contacts and recommendations or Civil Service. Chemical, electrical, industrial, mechanical, mining and metallurgical engineers were most successful with personal contacts and recommendations. Civil engineers found more positions through civil service. Almost 15 per cent stated that they had used other mediums and it is believed that a good portion of that group had been placed through their colleges. Despite the fact that so few engineers reported an engineering society as their employment medium, it must be recognized that such societies are an important factor in obtaining employment because they are pools of information for employment possibilities.

Eleven thousand one hundred seventy-seven engineers reported that, in December 1934, they were in the employ of public authorities. Only 45 per cent were under civil service, and a majority of them were in federal government service. Employment contracts for engineers engaged in public engineering, personal service, and private engineering are not reported to have increased their economic security. Most contracts were for relatively short periods of time or that type of separation contract which is designed to protect employers more than employees.

Almost one-third of the engineers reporting, as of December 1934, that they were in engineering positions, stated that they had pension privileges. Almost 19 per cent were contributing and more than 11 per cent were subject to noncontributory schemes. The largest percentage of those covered were employed by the Federal government and the smallest group were in personal service.

* * *

The Committee on Professional Training of the ECPD, has recently issued a series of six informative pamphlets. The first deals with university extension facilities and consists of a survey of educational facilities, the general scope of courses included in those educational institutions, and general information as to their availability to young engineers in various localities where these institutions are located.

The second series of five pamphlets is the development of the original selected bibliograph of engineering subjects, this time extended into several sections and including mathematics; mechanics and physics, aeronautical and civil engineering; chemical and industrial engineering; electrical and mechanical engineering; and metallurgy, mineralogy, geology, and mining engineering.

The complete series is informative and instructive and of particular value in helping young men determine the sources of information available to them for different studies in a wide variety of fields. The pamphlets may be secured by writing to the Engineers' Council for Professional Development, 29 West 39th Street, New York City.

* * *

In response to complaints from a number of states to the effect that the WPA was appointing non-engineers to positions which should be filled by engineers, American Engineering Council took the matter up with the Works Progress Administration and urged that steps be taken to correct the increasingly dangerous practice. After several staff discussions, Col. F. C. Harrington, assistant administrator and chief engineer, has offered the following suggestions which seem worthy of careful consideration and practical application:

"It seems desirable to point out in this connection that the responsibility for the engineering and architectural design of all work undertaken by the Works Progress Administration rests upon the local governmental units sponsoring the projects. For some projects the sponsors furnish all necessary supervision, but in any event they have the further duty of assuring themselves that the work is being performed in accordance with their plans and specifications. There has been a great deal of difficulty in getting sponsors to make the proper provisions for carrying out these responsibilities, and anything that your organization can do to improve conditions in this respect will be appreciated.

"Under these conditions, the functions of the Works Progress Administration are similar to those of a general contractor, and the effort has been to secure men in responsible positions who have had practical experience in the organization and operation of construction work, rather than engineers who have specialized in design. The ideal man is, of course, the qualified professional engineer who has had the desired practical experience, but it is becoming increasingly difficult to secure or to hold such men at the salaries which it is possible to pay in a work-relief program. The local affiliates of your organization can be of service to the state and local Works Progress Administrations by the preparation of lists of men who are known to be properly qualified, who are in sympathy with the purposes of a work-relief program, and who will accept employment at the salaries offered. I am sure that the state administrators will be very grateful to have such cooperation.

"In states where unsatisfactory conditions are believed to exist with respect to engineering practices, it would be helpful if the local engineering societies affiliated with the American Engineering Council would take up these matters with the state administrator or the state director of operations. In case this action is impracticable or does not bring about the results hoped for, I will be glad to give consideration to any specific cases which you care to bring to my attention."

* * *

Experts in the production, distribution, and use of bituminous coals are being mobilized by both the National Bituminous Coal Commission and the Consumers' Counsel created by the Bituminous Coal Act of 1937. Engineers who are interested should contact Commissioner C. E. Smith of NBCC, Investment Building, Washington, D. C., or Ellery P. Gordon of the Consumers' Counsel of NBCC, Tower Building, Washington, D. C. Junior and senior engineers are being employed by both organizations.

Civil service rules are being applied to junior positions and political sponsorship is required for expert and executive candidates. Civil Service salary schedules have been adopted for all employees. The executives who are making personnel selections are stressing the value of practical experience and most positions call for college graduates. In addition to the staff for the Washington offices, 26 field offices are being organized in the soft coal producing and consuming areas.

Personals

George W. Kable has joined the publication "Electricity-on-the-Farm" as its editor, and will be located at the address of that publication, 4 West 40th Street, New York, N. Y. More recently he was research director of the National Rural Electric Project, and later chief of the agricultural engineering section, agricultural industries division, Tennessee Valley Authority.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

M. Hamilton Clark, agricultural representative, Caterpillar Tractor Co., Peoria, Ill. (Mail) 117 W. Armstrong St.

Melvin L. Falk, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Springfield, Colo.

Ward H. Henden, technical expert and foreman, U. S. Indian Service. (Mail) Howard, S. D.

Andrew J. Longley, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 836 Crockett St., Amarillo, Tex.

William F. Martin, assistant foreman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Palls, Va.

Bruce W. Reagan, A. & M. Press, Texas A. & M. College. (Mail) 2708 Homan Ave., Waco, Tex.

Don R. Richardson, farmer, Stewarts Point, Calif.

Donald F. Robinson, rural representative, Pacific Power & Light Co., Toppenish, Wash. (Mail) Box 583.

L. L. Sammet, instructor, agricultural engineering, Connecticut State College, Storrs, Conn.

John W. Sumner, rural service engineer, Appalachian Electric Power Co., Pulaski, Va.

William D. Test, Graham Farms, Washington, Ind.

Robert L. Thigpin, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 1211 N St., Nacogdoches, Tex.

William L. Wedel, student engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis. (Mail) 2818 W. Highland Blvd.

TRANSFER OF GRADE

Maurice W. Nixon, rural service engineer, Empire State Gas and Electric Association. (Mail) Agricultural Engineering Department, Cornell University, Ithaca, N. Y. (Junior to Member)

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

FLOW OF WATER AROUND 180-DEGREE BENDS, *D. L. Yarnell and S. M. Woodward.* U. S. Dept. Agr., Tech. Bul. 526 (1936), pp. 64, figs. 48. This bulletin presents the results of a series of experiments on the effects of 180-degree bends of square and rectangular cross section on the flow of water. The studies were conducted by the USDA Bureau of Agricultural Engineering in cooperation with the University of Iowa.

The purpose of the investigation was to explore the laws governing the changes in pressure and velocity in different parts of the flowing stream as the moving water undergoes the transition from motion along a straight path to motion around a curve, and again as it undergoes the opposite transition back to a final straight-line motion.

Experiments were conducted on 180-degree bends of two sizes and two radii. The first series of tests was made on a channel whose cross section was 10 in square with a 5-in inner radius. The next series of tests was made on a channel 5 in wide by 10 in deep, with a 5-in inner radius. The third series of tests was run on a channel 5 in wide by 10 in deep with a 10-in inner radius.

Tests were run with the channels flowing full and under some pressure in which the discharges ranged from 0.7 to 3 cu ft per second. Tests were also made with the channels flowing partly full. Duplicate experiments for several of the quantities were run as check tests.

Experiments were made on all bends with uniform velocity distribution in the approach channel near the beginning of the bend. Additional tests were run using the smallest and largest discharges in which unequal velocity distribution was purposely created in the approach channel near the beginning of the bend.

It was found that a smooth bend acts as an obstruction disturbing the distribution of pressure and velocity in the cross section for a short distance upstream from the beginning of the bend. As water approaches the beginning of a smooth bend, in the outside filaments the pressure always increases and the velocity decreases. In the inside filaments these changes are reversed. As water flows around a bend there must be higher pressure on the outside. With substantially uniform velocity distribution in the approach channel to the bend, the velocities of the filaments along the inside wall of the bend are increased while the velocities of the filaments along the outside wall are reduced. As water flows around a bend the effect of wall friction is to produce an unstable relation between the filaments flowing at different velocities, with the result that the filaments of highest velocity tend through a secondary circulation to drift toward the outer wall of the bend. At the end of the bend there is another rather abrupt rearrangement of pressures and velocities in the cross section whose effects persist for a considerable distance downstream from the bend.

HOP CURING. Rural Electrif. and Electro-Farming, 12 (1936), No. 137, pp. 95-97, fig. 1. A brief discussion of the essential factors involved in the process of hop drying is presented, indicating the advantages presented by the use of electrical equipment.

OILED-GRAVEL ROADS OF COLORADO, *E. B. House.* Colorado Sta. Bul. 426 (1936), pp. 29, pl. 1, figs. 3. This bulletin presents the results of several years' experimentation with oiled-gravel roads in Colorado. It has been found that conditions necessary for first-class oiled roads are (1) a well-compacted, dry subgrade, (2) adequate drainage, and (3) even distribution of oil throughout the matrix. To accomplish the last, the use of mixing machines in which the oil is under constant control is considered essential. It has been found that water in the aggregate up to 6 per cent improves the matrix and provides a stronger and better wearing road surface if the materials are well mixed. A fine material in the aggregate is considered to be of special importance and should amount to not less than 10 per cent.

Formulas from various sources for mixes are presented and discussed.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE COLORADO STATION. Colorado Sta. Rpt. 1936, pp. 23, 24, 35-37, 37, 38. Progress results are briefly presented of investigations on oiled-gravel roads, sugar beet machinery, and the design and development of irrigation equipment.

GASOLINE AND ALCOHOL-GASOLINE BLENDS, *L. T. Brown and L. M. Christensen.* Indus. and Engin. Chem., Indus. Ed., 28 (1936), No. 6, pp. 650-652, figs. 7; also in Proceedings of the Second Dearborn Conference of Agriculture, Industry, and Science, Dearborn, Mich., 1936. Dearborn: Farm Chemurgic Council, 1936, pp. 398-403, figs. 7. Tests are reported which were conducted at the Iowa Experiment Station. Their purpose was to study the influence of the engine speed upon the relative fuel consumptions of gasoline and a blend containing 10 per cent of ethanol and 90 per cent of the same gasoline at air-fuel ratios which might be employed in practice. In addition, the influence of the throttle opening at several speeds and with a carburetor setting typical of practical operation was also studied. The tests were conducted with a six-cylinder truck or bus engine of 4-in bore and 5-in stroke, developing its maximum power at about 2,300 rpm. The compression ratio was 4.85:1. The gasoline used was a 65-66 octane rating regular grade gasoline. Less cooling water was required with the blend than with the gasoline as the fuel, to maintain an outlet temperature of 150 F. There was no significant difference in the temperatures in other parts of the engine in shifting from one fuel to the other. The air-fuel ratio with a given speed, throttle opening, and carburetor jet was practically identical with the two fuels. The ratio with the blend was slightly lower with the 0.056-in jet and slightly higher with the 0.068-in jet. In effect, the substitution of the blend resulted in a mixture ratio slightly weaker than that obtained with gasoline under the same conditions.

The air-fuel ratios varied from 11-1 to 16-1. Within this range the power output is ordinarily increased by a decrease in the air-fuel ratio. Except at the higher speeds and with the highest air-fuel ratios, the blend gave a greater power output than did the gasoline. This result was obtained in spite of the fact that the mixture ratio was, in effect, smaller with the gasoline.

The blend gave appreciably less carbon monoxide under a given set of conditions than did the gasoline, but there was no definite ratio. In general, the decrease in carbon monoxide production could be accounted for on the basis of the difference in oxygen requirements of the two fuels. That is, if the two fuels were used with mixture ratios containing the same ratio of oxygen required to oxygen present, the carbon monoxide content of the exhaust gas would be the same for the two fuels.

The relative power output with the gasoline and the blend was affected by air-fuel ratio and engine speed, whereas the throttle position apparently had little or no influence upon the relative values. With the highest air-fuel ratios (15 or 16:1) and the higher engine speeds (1,600 to 2,000 rpm) the blend was inferior to gasoline, but with the lower air-fuel ratios, and particularly at low engine speeds, the blend gave the greater power output.

In general, the blend was favored by low air-fuel ratio, low engine speed, and small throttle opening. There was no single relation between the relative specific fuel consumptions with the two fuels.

The data indicate that the carburetor setting with the gasoline and the 10-per cent blend should be the same for satisfactory practical operation. Operations at low speed and at part throttle were particularly favorable as regards comparative advantage of the blend over gasoline, under which conditions the 10-per cent alcohol blend gave slightly greater power output, appreciably lower specific fuel consumption, and a 30 to 50 per cent lower carbon monoxide production than was obtained with the gasoline alone.

SOME FUNDAMENTAL PRINCIPLES OF DRYING, *E. A. Fisher.* Jour. Soc. Chem. Indus., Trans., 54 (1936), No. 42, pp. 343T-348T, fig. 1. This is a technical discussion of basic principles involved in the process of commodity drying.

ARTESIAN WATER IN THE FLORIDA PENINSULA, *V. T. Stringfield.* U. S. Geol. Survey, Water-Supply Paper 773-C (1936), pp. IV + 115 + 195, pls. 11, figs. 9. This report is based on the results of a general survey of the artesian water in the Florida peninsula. The essential data are presented largely in graphic form.

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Agricultural Engineering Digest

(Continued from page 368)

STORING CHOPPED ALFALFA HAY IN VENTILATED CONTAINERS, *B. H. Roche.* Amer. Soc. Anim. Prod. Proc., 1935, pp. 259-262. This is a brief presentation of results of experiments conducted at the Wisconsin Experiment Station cooperatively by the departments of agricultural engineering and animal husbandry.

It was found that chopping hay at the time of storing in the barn or in ventilated containers has many advantages. The investigations were conducted with six wooden bins on a weighing track. These bins varied from 3 to 6 ft wide, 7 to 8 ft long on the inside, and 10 ft deep, and a larger bin was 9 ft wide, 15 ft long, and 12 ft deep. The side and end walls were double with 1x2-in slats spaced 1 in apart, making up the inside wall, while the outer wall was of matched boards. There was an air space of 6 in between the walls with openings to the outside at all four corners, allowing free movement of air between the slatted and the solid walls. The floor was tight. In addition to the wooden units, an all metal unit, with the exception of the floor and end sections which were wood, was used. This provided a double-walled container comparable to some commercial chopped hay storage structures. It was made of galvanized steel sheets with louvres (perforations) on the inside wall next to the hay and tight metal sheets for the outside walls. The design of the two metal walls was such as to permit a vertical movement of the air, carrying upward the heat produced in the hay in much the same manner as a chimney.

Chopped alfalfa, both first and second crop, of varying moisture content, was stored in each of the different containers. The hay was run through an ensilage cutter set on the ⅜, ½, or 1-in cut.

With the equipment and length of cut used, it was concluded that in order to retain the maximum nutritive value the hay must be fully as well cured as is the ordinary practice with unchopped hay. However, some evidence was obtained that with a very narrow width of container, more completely ventilated walls, and a longer cut, thus decreasing the density, good results might be secured with hay of slightly higher moisture content.

THE CALORIFIC VALUE OF DECAYED CORDWOOD, *M. T. Hilborn.* Phytopathology, 26 (1936), No. 9, pp. 905-914, fig. 1. In studies conducted at the Maine Experiment Station, the effect of decay on specific gravity and calorific value was measured in split and unsplit wood of three species—red maple, *Acer rubrum* L.; paper birch, *Betula papyrifera* Marsh.; and beech, *Fagus grandifolia* Ehrh., in two types of situations over a period of 4 yr.

Specific gravity of the wood when air dried was found to be higher in split wood, presumably from trunks, than unsplit wood, presumably from branches. As the specific gravity decreased the calorific value of the wood, air-dried, also decreased somewhat, indicating a change in chemical composition. The calorific value decreased somewhat faster in the woods than in an open field, faster in the split than in the unsplit form, and respectively more rapidly for the maple, beech, and birch in the round form. Correcting the calorific value for water content, which increased with decay, the net, or practically useful fuel value was found to decrease in 4 yr as much as 89.4 per cent for the round white birch from the woods, and as little as 35.9 per cent for the round red maple from the open field. The decrease was as much as 50 per cent in less than 2 yr in some of the birch wood.

THE EFFECT OF WIND EROSION AND CULTIVATION ON THE TOTAL NITROGEN AND ORGANIC MATTER CONTENT OF SOILS IN THE SOUTHERN HIGH PLAINS, *H. A. Daniel and W. H. Langham.* Jour. Amer. Soc. Agron., 28 (1936), No. 8, pp. 587-596, figs. 2. The authors determined, at the Oklahoma Experiment Station, the total nitrogen and organic matter in cropped, virgin, and drifted soils of the southern high plains. The drift had an average of 24.5 per cent less organic matter and 28 per cent less nitrogen than the virgin soil.

"The data indicate that each time a soil is shifted more plant nutrients are removed, and that after being moved a large number of times the dunes from soils that are dispersed by the wind finally became sand, regardless of the original texture. The organic matter : nitrogen ratios were determined, and it was found that this ratio in the cropped soil was 22.47 and that in the virgin 23.3, while the average of the drifts was 24.44.

"Since the total nitrogen and organic matter in the soil profile decreases rapidly with depth, the data clearly prove the great necessity for retaining the surface soil. As a result of cropping and wind erosion, the organic matter in the cultivated soils was decreased 18 per cent and the nitrogen 15 per cent. Very little difference occurred in the nitrogen and organic matter content of the cropped and virgin subsurface soils."

THE CORROSION OF CEMENT.—I, PORTLAND CEMENT AND WATER, *E. B. R. Prideaux and B. G. Limmer.* Jour. Soc. Chem. Indus., Trans., 54 (1935), No. 42, pp. 348T-354T, figs. 5. Studies conducted at University College, Nottingham, England, are reported in which conductivities and hydroxyl-ion concentrations (as pH by the hydrogen electrode) were used to determine the concentrations of calcium hydroxide dissolved from the pure solid as a standard. The solubility of pure lime obtained by these methods and potentiometric titration was found to be in good agreement with results of previous workers. The conductivity method thus standardized was found to be the more delicate in following slight changes of concentration. These methods were then applied to an investigation of the corrosion of portland cement by pure water, it having been found that the presence of aluminates and calcium sulfate dissolved from the cement had relatively slight effects. Cylinders of neat cement were extracted with water under various conditions, and figures were obtained for the amounts of lime removed per unit surface of cement and volume of solution. For the same times these amounts increase with increase in the ratios surface of cement : volume of solution. The initial effect of an inert aggregate on rate of corrosion was negligible, but in the later stages this rate was lower for a concrete than for a neat cement. Rates of removal of lime and concentrations of extracts were compared in the cases of pats and powders, respectively. About a quarter of the weight of powdered cement was removed by successive extractions with water. The most important factor governing the percentage dissolved is the ratio of volume of water : surface of cement. The rate of corrosion of massive pieces in the early stages resembles the rate of dissolution of a pure substance, but in the later stages it appears to be more determined by rate of diffusion of lime through the surface of the solid. A typical hard water was found to remove more lime than pure water under the same conditions, and the (sulfate) hardness of the water was thereby reduced.

INDUSTRIAL WASTES IN NEW JERSEY, *W. Rudolfs and L. R. Setter.* New Jersey Stas. Bul. 610 (1936), pp. 22. The results of an industrial waste survey covering the more highly industrialized areas of New Jersey are briefly summarized. The number of industries visited amounted to 1,792, and definite waste information was obtained from 1,213 industries. Since many industries were duplicated, samples of 401 were obtained, 251 of which were completely analyzed and 150 partly analyzed for confirmation. The water consumption from which the samples were collected amounted to 54,600,000 gal a day, and the liquid wastes discharged amounted to 43,651,000 gal a day. On account of the great diversity of industries and varying wastes produced, the collected samples were grouped under a number of headings, somewhat similar to those employed by the United States census.

On the basis of rather complete analyses the results were calculated as specific and general average wastes and expressed in pounds per employee a day. From the United States census reports data were obtained covering all industries of the state which fell into the types of industrial classifications made for the survey, so that all industries in the state producing wet wastes could be integrated, using as units the employees of each industry.

For the integration and checking, two methods of calculations were used, namely, the specific and the general mean. The results were summarized and expressed in tons of different types of solids, salts, and oxygen consumed per day. The quantity of wet suspended solids (5 per cent) produced by the industries amounts to 700,000 tons a year as compared to 900,000 tons of sewage solids. The settleable solids, effective in sludge bank formation, amount to nearly 100,000 tons as compared with about 450,000 tons of sewage sludge. On the basis of oxygen consumption the estimated population equivalents for the industries in the state amount to over 3,000,000, or as much as two-thirds of the total domestic waste produced by the entire population of the state. The waste of the different industries varies considerably in solids production and oxygen demand. The oxygen requirements of the waste produced per employee by the different industries were from 2.9 to 470 times greater than the oxygen demand requirements of the sewage of one person, and the suspended solids produced for each employee was from 2.4 to 181 times greater than the suspended solids produced per person as domestic sewage.

REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ENGINEERING, 1936, *S. H. McCrory.* U. S. Dept. Agr., Bur. Agr. Engin. Rpt., 1936, pp. 24. The progress results of investigations in irrigation, drainage, farm-operating efficiency, farm structures, farm machinery, and cotton ginning conducted by the Bureau of Agricultural Engineering during the fiscal year 1936 are briefly presented.

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Agricultural Engineering Digest

(Continued from page 374)

SHEET EROSION STUDIES ON CECIL CLAY, *E. G. Diseker and R. E. Yoder.* Alabama Sta. Bul. 245 (1936), pp. 52, figs. 9. This bulletin presents the results of 6 years' experimentation on the measurement and control of the sheet erosion process on Cecil clay. Its purpose is to present methods and procedure by which some of the basic principles involved in sheet erosion control may be analyzed and to apply these principles to Cecil clay. A set of 10 controlled plats, each 15 by 50 ft was used. Two plats were located on each of a 0, 5, 10, 15, and 20 per cent slope. Suitable equipment and methods were used to (1) measure the amount, rate, and nature of soil material eroded from the plats, (2) measure the rate and amount of runoff, (3) supply uniformly distributed artificial rainfall at any desired rate and amount, and (4) record the intensity, quantity, and duration of natural rainfall. Experiments were conducted under wide variations of soil condition and vegetative cover.

The moisture content of the soil influenced the rate and extent of absorption and hence influenced runoff and soil movement during any given rain. A large portion of seasonal erosion losses invariably resulted from a few heavy rains which occurred when the soil was approximately saturated.

Rainfall intensity was more important than the quantity of rainfall in determining the amount of erosion when other conditions were held constant and when the rate of rainfall exceeded the rate of infiltration to an extent that appreciable runoff occurred. With a given intensity of rainfall, the duration had a marked effect upon erosion—the greater the duration the greater the soil losses. Losses from intermittent rains of a given quantity were decidedly less than those from rains of continued duration, provided the rate of rainfall exceeded the rate of absorption. This was due to the inability of the soil to absorb the quantity of water during a given time. The exception to this was on smooth fallow, in which case the soil losses per unit of runoff decreased because the loose or slaked soil was readily carried off by the first part of the rain.

Pulverization and tillage practices which increased the rate and amount of absorption were very effective in controlling sheet erosion, provided the rate and amount of rainfall did not exceed the rate and amount of absorption. When the rate of rainfall greatly exceeded the rate of infiltration, excessive soil losses usually resulted from such tillage practices.

Aggregate analysis of sediments eroded from Cecil clay under a wide variety of conditions showed that the unit particles involved in the sheet erosion process, in the case of structural soils, were aggregates rather than textural separates. In general, soil material is moved layer by layer in the sheet erosion process. The relative loss of colloidal material may be excessive under a condition or combination of conditions which results in small quantities of runoff or in runoff of low velocity, or both.

Winter cover crops and other vegetative control measures functioned in reducing sheet erosion losses and soil movements by (1) filtering out the large soil particles and water stable aggregates, (2) decreasing the quantity of runoff, (3) decreasing the velocity of runoff, (4) minimizing the turbulence of runoff and hence lessening the abrasive or dispersive action of sediment-loaded water, and (5) by decreasing the mechanical dispersive action of beating rainfall.

Annual soil losses from land continuously in cotton were reduced to about one-half by the use of vetch as a winter cover crop. Rye, used as a winter cover crop, was nearly as effective as vetch in reducing erosion losses. Various width strips of soil-conserving crops were effective in reducing erosion and in decreasing the distance of soil movement on between-terrace slopes. It seems that if strip cropping is practiced, it should be used as a supplement to terraces rather than as a substitute for terraces.

Contoured, row-crop plantings had a pronounced soil and water-saving ability when compared to slope plantings. The amount of soil eroded from slope-planted cotton was about twice as much as that from contour-planted cotton.

Erosion losses increased with increased slope under all conditions studied. The so-called "critical slope" or point above which a given soil cannot be cropped without excessive erosion losses is more dependent upon such factors as plant coverage and tillage practices than on topography itself.

SUBSOIL WATERS OF NEWLANDS (NEV.) FIELD STATION, *C. S. Scofield, C. L. Moon, and E. W. Knight.* U. S. Dept. Agr., Tech. Bul. 533 (1936), pp. 31, fig. 1. The purpose of this report is to discuss conditions in respect to the subsoil water that constitutes one of the features of the problem of crop production not only on the Newlands Field Station but elsewhere on the Newlands reclamation project.

The observations were made by means of a number of wells, 83 in all, comprised in 5 groups. The records include weekly observations of elevation in the wells of some groups and monthly observations in the others.

The saturated zone has a surface gradient to the south and east approximately conformable to the ground surface and equivalent to approximately 5 ft per mile. The mean annual range in elevation from the low of early spring to the high of midsummer is somewhat less than 3 ft.

The evidence of the water-elevation data indicates that the subsoil water is intercommunicating throughout the area of the field station, yet notwithstanding the appreciable gradient of its surface there does not appear to be lateral movement in the mass at a measurable rate.

The salinity of the subsoil water has been determined by samples from the wells taken monthly or less frequently throughout the year. There are pronounced differences in the salinity of the water obtained from the different wells, and in general these differences remain fairly constant.

Changes in elevation of the subsoil water occur approximately simultaneously in adjacent wells, thus indicating hydrostatic intercommunication, but the persistent differences in salinity between adjacent wells indicate that there is a very slight general lateral movement of the water.

Observations have been made also on the salinity of the irrigation water and on that of the water collected by an open drain contiguous to the station. These observations show that the mean concentration of the subsoil water is from five to six times as high as that of the irrigation water, while the concentration of the drainage water is intermediate between these two.

Taken as a whole the evidence from these observations indicates: (1) that the subsoil water is replenished in part by percolation from the unlined canals of the distribution system and in part by the downward percolation of the irrigation water applied to the land, and (2) that the lateral movement in the direction of the surface gradient of the saturated zone does not occur uniformly but rather through the more permeable sections of the subsoil.

The hydrostatic readjustments by which the seasonal changes in elevation are kept uniform appear to be transmitted through or around the less permeable sections of the subsoil and to be accomplished with very little movement in the mass of the subsoil water.

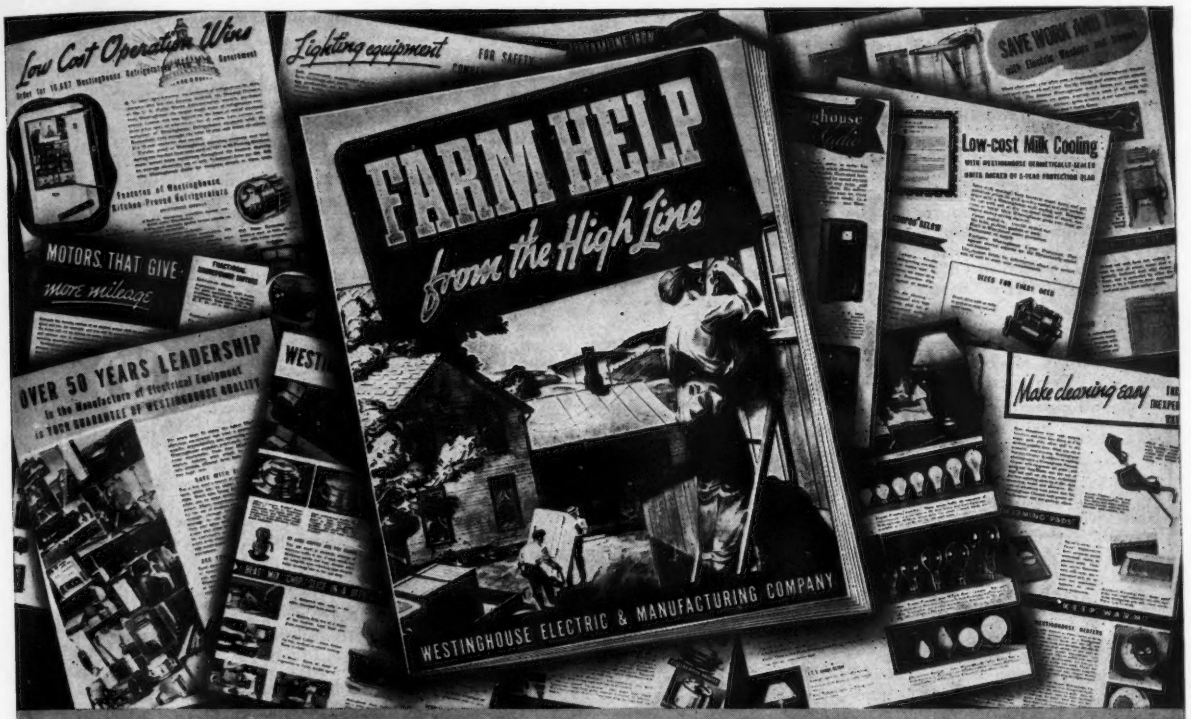
In some areas of the station the salinity and the boron content of the subsoil are so high as to retard or even to inhibit the growth of crop plants when this water invades the root zone of the soil.

GIN DAMAGE OF COTTON IN RELATION TO RAINFALL, *G. R. Smith.* North Carolina Sta. Bul. 306 (1936), pp. 26, figs. 6. An investigation in cooperation with the USDA Bureau of Agricultural Economics, 1933-35, involving many thousands of cotton samples from a number of gins in the principal cotton-growing districts of North Carolina ginned during the months of August to December, inclusive, showed that the percentage of gin-damaged cotton is highest at the beginning of the season, decreases rapidly each month until November, and remains about the same through December. A closer relationship appeared to exist between rainfall and gin damaged during the early part of the harvest season. At this time the water content of the plant and seed is higher, and the same amount of rainfall is more effective. The cotton reduced one or more grades, due to the lint being damaged during ginning, amounted in the fall of 1935 to 9.3 per cent, in 1934 9.5 per cent, and in 1933 5.2 per cent. Each year the percentage damaged was higher in the Tidewater and the Coastal Plain areas than in the Piedmont and Slate Belt areas.

Practical conclusions are that cotton farmers can improve the grade of their cotton and promote good ginning by bringing the ginner cotton in good ginning condition. Although cotton should be harvested promptly, it should not be picked while wet or too green. Cotton if picked damp or green should be allowed to dry before taken to the gin, for if ginned while containing excessive moisture the lint will be damaged and more lint will be left on the seed.

MACHINE MILKING COMPARED WITH HAND MILKING, [trans. title], *H. W. Eskedal.* Beret. Forsogslab. K. Vet. og Landbohojskoles [Denmark], 160 (1935), pp. 74, figs. 20; Eng. abs., pp. 72-74. Based on a series of trials comparing the effectiveness of machine and hand milking, it is concluded that hand-milked cows will yield more milk than machine-milked cows, due primarily to the slower rate of decline with advance of lactation in the former group.

(Continued on page 380)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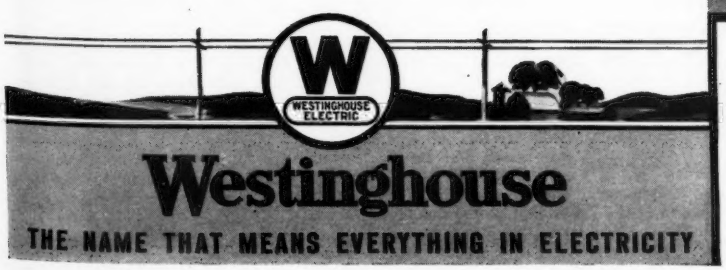

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Agricultural Engineering Digest

(Continued from page 376)

THE RATE OF MILKING BY MACHINE, *A. S. Foot.* Jour. Dairy Res. [London], 6 (1935), No. 3, pp. 313-319, figs. 6. In a study of the response of individual cows to milking machines, conducted at the National Institute for Research in Dairying, a wide range in duration of milking was observed, the coefficient of correlation between yield and milking time being 0.429. Curves showing the rate of milking at various stages during the operation for different yield groups are presented. Maximum rate of flow was reached in about 2 min for all yield groups, with high-yielding cows showing a much more rapid rate of flow and a more rapid decrease near the end of the milking period.

CALIBRATION OF COTTON PLANTING MECHANISMS, *H. P. Smith and M. H. Byrom,* Texas Sta. Bul. 526 (1936), pp. 32, figs. 22. Tests were made on cell-drop and picker-wheel drop cotton planting mechanisms to determine the quantity of cottonseed planted per acre and the percentage of seed hulled in passing through the different types of planting mechanisms.

The smallest number of cottonseed dropped per acre by the cell-drop planting mechanisms tested was 39,776 at low-plate speed, while the largest number was 254,724 seed at high-plate speed. This is equivalent to 8.61 and 55.16 lb, or approximately 0.25 and 1.75 bu per acre.

Picker-wheel drop planting mechanisms had a wider spread than the cell-drop planting mechanisms between the minimum and maximum quantities of seed dropped, ranging from 33,996 to 549,064 seed per acre. The equivalent in pounds is 7.36 and 118.87, or approximately 0.25 and 3.5 bu per acre.

The size of the seed materially influenced the quantity of seed dropped. When the same plates and speeds were used to drop medium-sized Truitt cottonseed, from 47,569 to 87,043 more seed were planted per acre than with the larger-sized Ducona seed. Seed dropped by picker-wheel drop mechanisms ranged from 43,085 to 151,068 more medium-sized Truitt seed than large Ducona seed per acre.

The percentage of seed hulled by cell-drop planting mechanisms ranged from 0.001 to 1.47 per cent. The highest percentage of seed hulled by picker-wheel drop planting mechanisms was 0.46 per cent.

If 70 per cent of the smallest and largest number of seed dropped by cell-drop planting mechanisms germinated, the number of plants obtained would range from approximately 2 to 12 per foot. To obtain a perfect stand of 14,520 plants per acre, from 1 to 11 plants per foot would have to be thinned out. The number of plants per foot for picker-wheel drop mechanisms ranged from 2 to 27, requiring the removal of from 1 to 26 plants per foot to leave 1 plant per foot.

THE RELATION OF WASHING TREATMENTS TO SUBSEQUENT LOSSES IN MOISTURE FROM APPLES, *R. E. Marshall, F. L. Overley, and K. Groves.* Washington Sta. Bul. 330 (1936), pp. 28, figs. 9. Using for the most part apples harvested from experimental spray plats near Wenatchee and stored at a temperature of from 32 to 34 F and at a relative humidity of 80 to 85 per cent, the authors found that, although all the washing treatments employed resulted in some subsequent acceleration of moisture loss rates, apples may be held in well constructed and well managed cold storage plants during the usual storage season without appreciable loss of moisture, irrespective of the washing treatments. Increased loss of water from apples washed in hydrochloric acid, sodium silicate, soda ash, or aluminum chloride solutions at temperatures not in excess of 110 F were not of serious proportions. The addition of mineral oil to the washing solution caused some acceleration in subsequent rate of moisture loss, and the most severe washing treatment with respect to moisture loss was that of tandem acid and silicate solutions, both fortified with mineral oil and heated to 120 F. Although certain small but consistent differences were observed in rates of water loss from apples from the different spraying plats, the differences were not significant enough to concern the grower.

OIL BURNERS FOR HOME HEATING, *A. H. Senner.* U. S. Dept. Agr. Circ. 406 (1936), pp. 27, figs. 13. This circular is a revision of and supersedes Circular 405, and relates only to power-operated types of oil burners. Practical information of a technical character is presented.

DUST EXPLOSION AND FARM FIRE INVESTIGATIONS, U. S. Dept. Agr., Bur. Chem. and Soils Rpt., 1936, pp. 29-32. Progress results are briefly reported.

CONDITIONS INFLUENCING EROSION ON THE BOISE RIVER WATERSHED, *F. G. Renner.* U. S. Dept. Agr., Tech. Bul. 528 (1936), pp. 32, figs. 14. This bulletin presents an analysis of the data collected during an intensive survey of erosion and related factors on the most seriously affected parts of the drainage within the Boise National Forest. The purpose of the study was to determine the influence on erosion of the several factors, both natural and artificial, for use as a guide in planning protection and management of this and other watershed areas where similar conditions prevail.

With other factors equal, the amount and severity of the erosion was found to vary directly with gradient. Actually, however, the erosion increased as the gradient increased only up to approximately 35 per cent; beyond this point, because other factors are not equal on steeper areas, the erosion decreases. On the steeper slopes, these factors, chiefly lighter grazing by livestock, are sufficiently powerful to reverse completely the trend toward increased erosion with increased gradient.

The causes of erosion were found to be most operative on southerly aspects. On northerly exposures, differences in temperature and moisture conditions gradually have brought about a vegetation cover which is more effective in its ability to hold the soil and prevent erosion. This vegetation in turn, and to a greater extent than on southerly aspects, has improved soil conditions through additions to the litter and organic matter. Moreover, the maintenance of these improved conditions on northerly aspects has been favored by lighter rodent infestations and less use by livestock.

Serious losses of the topsoil have occurred over extensive areas. With their normally coarse texture and comparative lack of binding properties, even the soils where this top layer can still be found erode easily. The loss of litter and organic matter through the removal of the top layer has still further reduced the soil's resistance to erosion and therefore has aggravated the effect of the factors of steepness, scant vegetation, rodent infestation, and overgrazing.

Erosion conditions differ sharply on the various range types. The weed and grass types in particular have suffered severely, and even in the sagebrush, browse, and timber types much damage has been done. It is significant that the more seriously eroded types are those whose soil conditions have been the most disturbed by rodents and grazing.

A vegetation cover of less than 30 per cent appears to have little appreciable effect in retarding erosion. Since this scant cover is found on more than one-half of the watershed, the vegetation in its present depleted condition is largely ineffective in the prevention or control of erosion. As the density of the vegetation increases above 30 per cent, the erosion rapidly decreases, and apparently a cover of 40 per cent is sufficient to prevent gully erosion under normal conditions of grazing use. These facts indicate the necessity, in order to secure full effectiveness of the cover, of maintaining a vegetation density of 30 per cent or more.

Rodents appear to have been an important factor contributing to the accelerated erosion. These animals have partially depleted the vegetation and disturbed the soil over four-fifths of the area studied. In addition, their effect upon erosion has probably been increased by their habits of concentration on southerly exposures and other areas which are heavily grazed by livestock.

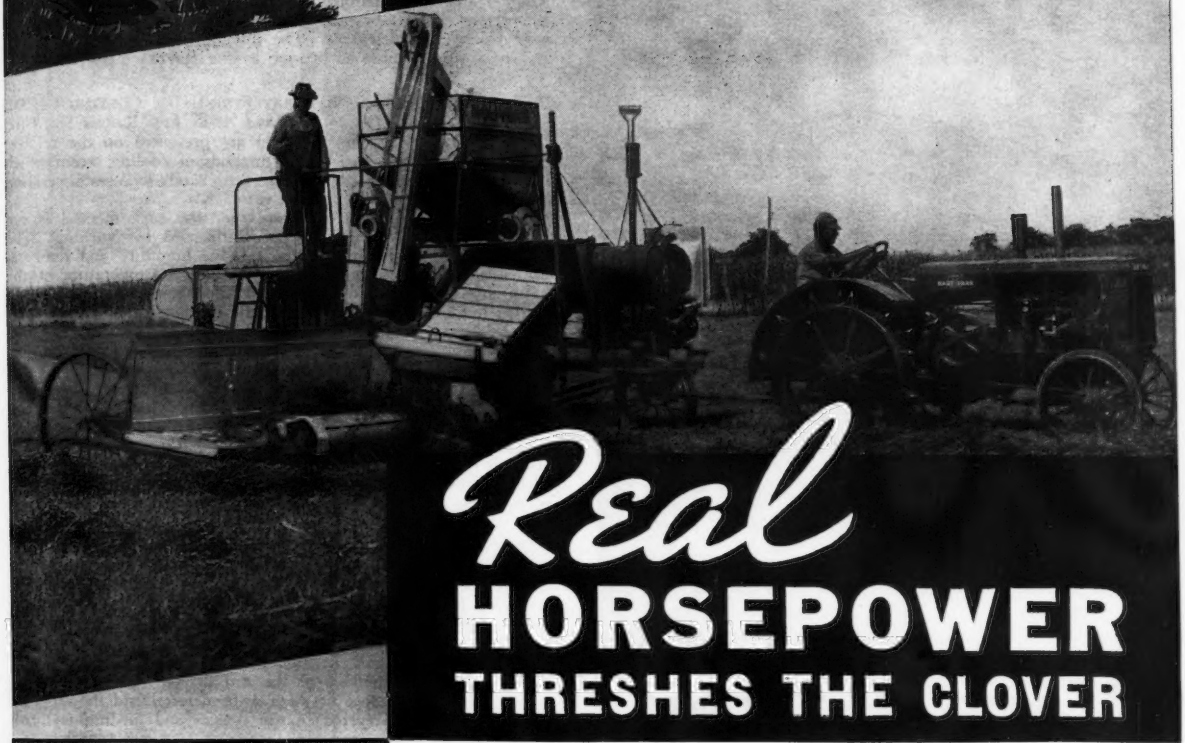
The erosion was found to vary directly with the degree to which the vegetation cover has been depleted and the surface conditions disturbed by the grazing of livestock. Almost without exception, the areas which have been grazed most heavily are examples of the most severe erosion. On an area with the steep slopes, loose, coarse soil, and scant vegetation characteristics of this watershed, the degree of use by livestock appears to be of far more importance in its effect upon erosion than any other of the factors studied.

GROUND-WATER RESOURCES OF KLEBERG COUNTY, TEXAS, *P. Livingston and T. W. Bridges.* U. S. Geol. Survey, Water-Supply Paper 773-D (1936), pp. II + 197-232, pls. 5, fig. 1. This report, prepared in cooperation with the Texas Board of Water Engineers, presents the results of an investigation of the geology and ground-water resources of the area.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE TEXAS STATION, *R. E. Dickson, B. C. Langley, H. P. Smith, D. T. Killough, and D. L. Jones.* Texas Sta. Rpt. 1935, pp. 63, 132-136. The progress results are briefly presented of investigations on mechanical harvesting of cotton, mechanical snapping of cotton bolls, factors of efficiency in the distribution and placement of cottonseed and fertilizer, calibration of cotton planters, planting of cottonseed at varying and uniform depths, planting of delinted and Ceresan-treated cottonseed, and run-off water losses in relation to crop production.

(Continued on page 382)

PAPER HORSEPOWER
SITS DOWN ON THE JOB . . .



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Agricultural Engineering Digest

(Continued from page 380)

ABSORPTION OF ULTRAVIOLET LIGHT BY CELLOPHANE AND BY PLANT ORGANS AND TISSUES [trans. title], *E. Gilles.* Compt. Rend. Acad. Sci. [Paris], 202 (1936), No. 11, pp. 968-970. Using both spectroscopic and photoelectric methods and the mercury vapor lamp as light sources, cellophane proved, in general, to be notably transparent to ultraviolet rays, and it may be used to replace quartz in certain physiological tests. Plant cells also may be much more permeable to these rays than generally supposed. The lower epidermis transmitted all the spectrum of the mercury vapor lamp. Leaves of *Begonia, Tradescantia, Oxalis, Plantago,* and *Salvinia* and the extremities of leaflets of *Cystopteris* were almost completely opaque, but the leaves of *Elodea* taken near the bud were relatively transparent. The integuments of seeds of lentils and peas were almost as opaque as the leaves.

THE EVAPORATION AND SPRAY SYSTEMS OF COOLING CREAM, *W. H. Martin, W. J. Caulfield, and A. C. Fay.* Kansas Sta. Circ. 180 (1936), pp. 16, fig. 1. Data are presented on the relative effectiveness of these two simple methods of cooling cream which are commonly employed on the farm and in cream-receiving stations.

The efficiency of the evaporation or wet sack method is not materially affected by the type of cloth used for wicking. The degree of air circulation and the relative humidity and temperature of the atmosphere as well as the initial temperature of the cream affect the rate of cooling, while room temperature and relative humidity largely determine the ultimate attainable temperature. Average room temperatures of 85, 86, and 98 F at relative humidities of 49, 69, and 33 per cent result in can temperatures (cooled by evaporation) of 70, 78, and 75 F, respectively. The efficiency of the spray method of cooling is primarily dependent upon the temperature of the water and the volume of water delivered per unit of time. The use of sack coverings did not increase the efficiency of this method, indicating that evaporation plays a relatively small part in spray cooling. Sour cream, due to its greater viscosity, cools more slowly and less uniformly than sweet cream unless agitated frequently during the cooling process.

THE PHYSICAL CHANGES IN SOILS OF THE SOUTHERN HIGH PLAINS DUE TO CROPPING AND WIND EROSION AND THE RELATION BETWEEN THE SAND+SILT/CLAY RATIOS IN THESE SOILS, *H. A. Daniel.* Jour. Amer. Soc. Agron., 28 (1936), No. 7, pp. 570-580, figs. 4. At the Oklahoma Experiment Station the mechanical analyses of a large number of cropped and virgin surface and subsurface soils of the southern high plains were compared with the sand, silt, and clay contents of the soil drifts.

The greatest difference between drift material and the cropped and virgin surfaces occurred in the coarse- and medium-textured types. The drifts contained an average of 37.8 per cent less silt and clay and 29.3 per cent more sand than the adjacent virgin soil. The increase in percentage of sand in the drifts was in proportion to the amount of silt and clay removed by the wind shifting the soil.

The sand+silt/clay ratios in these soils compared to that in the drifts. "The drift from the coarse-textured soils had the highest clay ratios and the clay soils the lowest; however, the data reported seemed to indicate that there was very little relation between the clay ratio and wind erosion."

STANDARD METHODS FOR THE EXAMINATION OF WATER AND SEWAGE, *A. Wolman, M. Pirnie, and H. E. Jordan.* New York: Amer. Pub. Health Assoc., 1936, 8. ed., pp. XIV+309, figs. 9. In a further revision the authors have modified boiler-water methods, included simplified procedures for parts of the bacteriological work, included a centrifugal concentration method in the procedure for microscopic examination, rewritten the sections on turbidity, odor, and chloride content, and added to the section of provisional methods.

WORK ON WINTER SOIL-CONSERVING CROPS IN THE SOUTHERN REGION AND NEARBY STATES. U. S. Dept. Agr., Agr. Adjust. Admin., South. Region Agr. Conserv., No. 2 (1936), pp. IV+54. This publication includes a digest of all available experiments with winter soil-conserving crops, published by experiment stations in the South since 1910 (and in a few cases earlier), and considers the effects of winter soil-conserving crops, as winter legumes and rye, on yields of cotton, corn, peanuts, pecans, wheat, sugarcane, and kale; the effects of dates and methods of turning under winter soil-conserving crops and liming on yields of succeeding crops; and the effects of inoculation, seeding methods, cutting dates, and fertilization on yields of winter soil-conserving crops.

(Continued on page 384)

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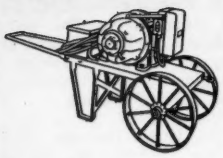
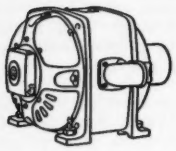
YOUR BEST GUARANTEE





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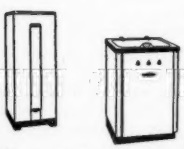

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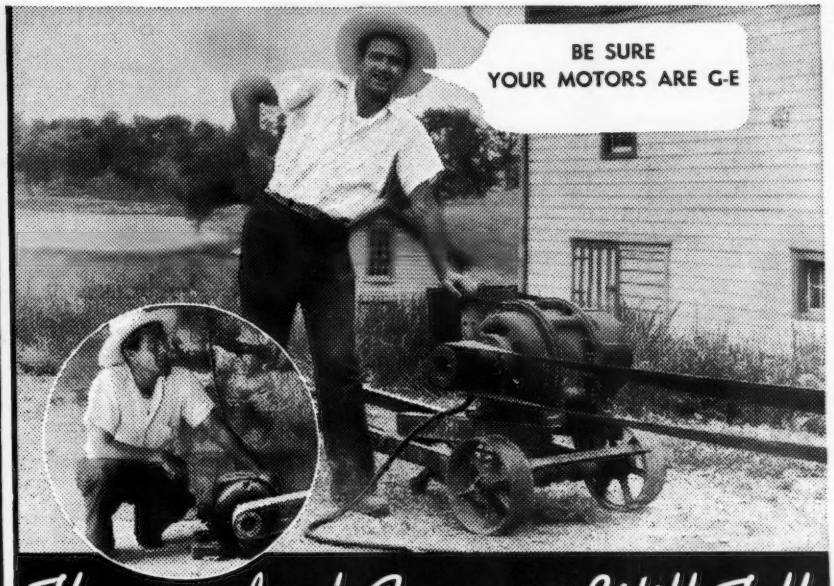

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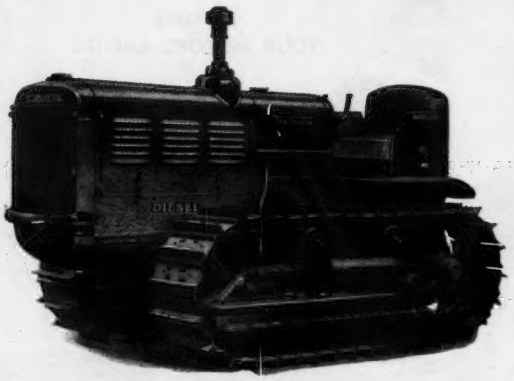

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Agricultural Engineering Digest

(Continued from page 382)

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE ARKANSAS STATION, *D. C. Carter, R. P. Bartholomew, L. C. Knapp, W. C. Hulburt, and R. M. Smith.* Arkansas Sta. Bul. 337 (1936), pp. 12, 13, 40. Progress results are briefly presented of investigations on farm house planning and design, durability of posts and methods of preservative treatment, water resources for rice irrigation, cost of terracing, and poultry housing.

BETTER BUYMANSHIP—NO. 20, HOME HEATING, *P. E. Mohn.* Chicago: Household Finance Corp., [1936], pp. 38, figs. 5. A large amount of practical information, much of it of a technical character, is presented on home heating. This relates to fuels, fuel selection, reducing fuel costs by proper construction, and the selection and installation of heating plants.

REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS, 1936, *T. H. MacDonald.* U. S. Dept. Agr., Bur. Pub. Roads Rpt., 1936, pp. 69. This report gives the usual progress data on the highway activities of the Bureau of Public Roads during the fiscal year 1936, and includes a section on physical research. This section presents progress results of investigations on subsurface exploration, motor-vehicle impact, measurement of road-surface roughness, design of concrete and flexible pavements, corrugated-metal culverts, bituminous and nonbituminous road materials, and subgrades.

Books Received

CONSERVATION OF THE SOIL, by A. F. Gustafson. Cloth bound, 6x9 in, XVII + 312 pages, 195 illustrations, indexed. McGraw-Hill, $3.00. Presented as a guide to land owners and operators, mortgage holders, county agricultural agents; and as a text or reference for college and high school courses in soil conservation, this book deals in a nontechnical way with the kinds of erosion, results, influence of precipitation and latitude, influence of slope and soil, influence of natural land cover, effects of crops and tillage, maintenance of organic matter and fertilization and rotation of crops, contour tillage and planting, contour strip cropping, terraces; meadows, pastures, and forests; control and elimination of gullies, control of wind erosion, control of wave erosion, control of erosion on public highways, and control of floods.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

DESIGNERS and layout men familiar with grain, hay, and corn harvesting machinery wanted by a leading manufacturer of farm equipment. Must be high-grade men. PO - 115.

ASSISTANT EXTENSION ENGINEER wanted by agricultural extension service of middle western state. Should be graduate agricultural engineer of middle western institution with knowledge of modern soil and moisture conservation practices. Man with several years experience in soil and moisture conservation work preferred. PO-117.

POSITIONS WANTED

AGRICULTURAL ENGINEER wishes employment as instructor, head of department, or research worker in an agricultural engineering school. Has mechanical engineering training, industrial and extension experience, and a degree in agricultural engineering. Has also done considerable work toward a masters degree, and wishes an opportunity to complete the work. Is now employed, but wishes to make a change to the educational field. PW-279.

AGRICULTURAL ENGINEER graduate of Kansas State College in the four-year course in agricultural engineering. Experience includes two years as camp engineer on erosion control work and two years in college extension in county agent and extension engineering work. Desires connection in college or industrial extension, farm machinery or farm management. Married. Age 24. PW-280.